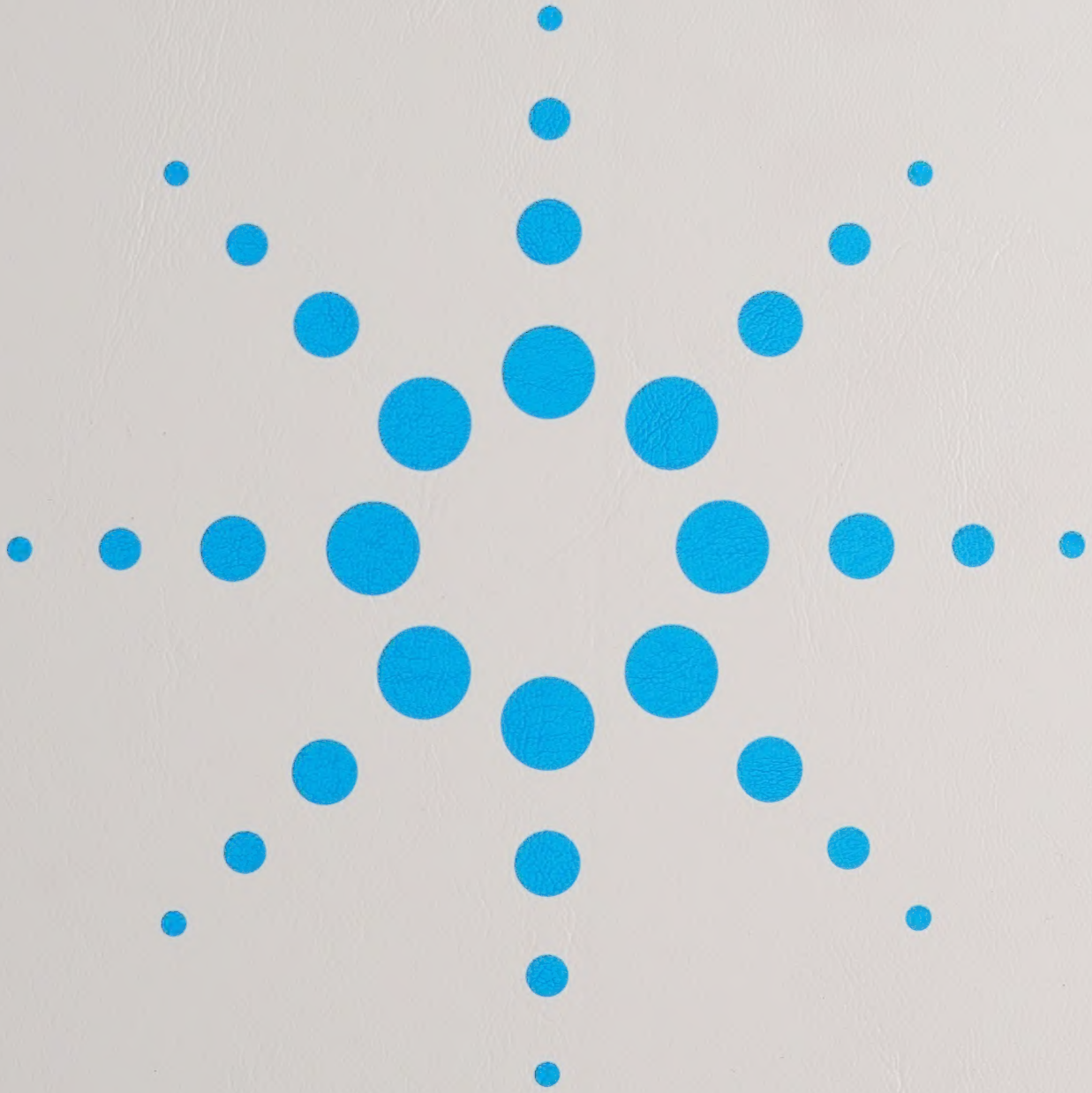

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HEWLETT® PACKARD

HP 4396B
Network/Spectrum Analyzer
Task Reference

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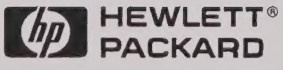
HP 4396B Network/Spectrum Analyzer

Task Reference

SERIAL NUMBERS

This manual applies directly to instruments with serial number prefix JP1KE, or firmware revision 1.00.
For additional important information about serial numbers, read "Serial Number" in Appendix A.



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First Edition

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1

Overview

This chapter contains the following information:

- Key Operation Overview
- Numerical Entries
- Character Entries

After chapter 2, the procedural steps do not contain as much detailed information. Therefore, you should read this chapter to understand the basic rules of analyzer's operation.

Key Operation Overview

Hardkeys and Softkeys

There are two types of front-panel keys; hardkeys and softkeys. Most hardkeys that have a label display function menus on the right side of the display. These function menus are also called softkey menus.

Softkey menus list functions other than those accessed directly by the hardkeys. To activate a function that is on a softkey menu, press the key located to the right of the displayed function label.

This manual uses the following conventions:

(Hardkey)	Indicates a hardkey
`Softkey`	Indicates a softkey

Toggle Keys

Some softkeys toggle menu settings. On a softkey label, the currently active setting is displayed in high intensity and upper case characters. The inactive setting is displayed in low intensity and lower case characters.

This manual shows a toggled setting as follows:

- Toggle `DUAL CHAN on OFF` to `ON off`.

This line means that the dual channel function is currently OFF. You turn it ON by pressing the corresponding softkey. The resulting upper case expression, `ON`, shows that the function is now active (ON).

For more information about each hardkey and softkey, see the *Function Reference* manual.

Numerical Entries

A numerical data entry is preceded by some function settings. For example, before entering a center frequency you must specify the center frequency value. The analyzer provides the following three ways to enter numerical data:

Using	Description
Numerical keys [0] .. [9]	Enters numerical data directly and terminates the entry using the units terminator keys. This capability is useful when you know the value you must enter. For example, to enter 1 MHz, press [1] [M/μ].
[↑] and [↓] key	Increments or decrements the settings. This is useful for changing settings broadly.
Rotary knob	Changes settings continuously. This is useful if you want to change the setting while verifying changes on the display.

Notes

You can use following techniques when entering numerical data:

- If you enter a wrong character, press [Back Space] to erase the last character entered.
- If you want to clear the current entry, press [Entry Off].

Character Entries

Save, recall, and display title functions require character entries. When a function that requires character entry is activated, a character entry menu is displayed (see Figure 1-1).

You can enter the characters by using following procedure:

To Enter Characters

1. Move the cursor ("↑") under the character you want to enter.
2. Press SELECT LETTER or [×1].
3. Repeat step 1 and 2 until all characters are entered.
4. Press DONE.

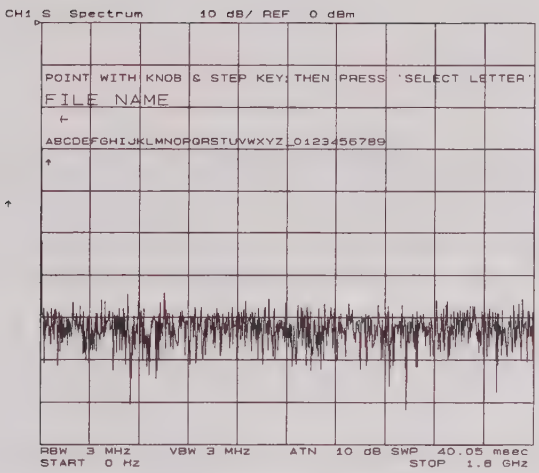
CH1 S Spectrum 10 dB/ REF 0 dBm
POINT WITH KNOB & STEP KEY; THEN PRESS 'SELECT LETTER'
FILE NAME
ABCDEFGHIJKLMNOPQRSTUVWXYZ_0123456789
RBW 3 MHz VBW 3 MHz ATN 10 dB SWP 40.05 msec
START 0 Hz STOP 1.8 GHz

Figure 1-1. Character Entry Menu

You can use the following techniques when entering characters:

- If you want to use different case characters, press ⇧ and ⇩ to toggle the upper and lower case of an alphabet list:

  ABCDEFGHIJKLMNOPQRSTUVWXYZ_0123456789
  abcdefghijklmnopqrstuvwxyz_0123456789

- If you enter a wrong character, press BACK SPACE or Back Space to erase the last entered character.
- If you want to clear the current entry, press ERASE TITLE .

If the keyboard is connected, you can use it for the character entry. (Option 1C2 only)

2

Recommended Spectrum Measurement Task Sequence

This chapter describes a typical task sequence commonly used for any measurement using the spectrum analyzer mode.

If you are using the analyzer for the first time, see the *User's Guide* first. The *User's Guide* provides the information needed to install and set up the analyzer, and a quick start guide to introduce you to the analyzer.

The measurement tasks described in this chapter are as follows:

- Step 1: Preparing for a measurement
- Step 2: Setting the trigger
- Step 3: Selecting the measurement format
- Step 4: Setting the frequency range
- Step 5: Setting the vertical settings
- Step 6: Tuning the settings
- Step 7: Performing calibration
- Step 8: Reading the measured result

Generally, you can make a measurement by performing these steps. If you want to perform a more complex spectrum measurement, chapter 3 provides additional measurement techniques.

Step 1: Preparing for a Measurement

This step prepares the analyzer for a spectrum measurement. You must perform the following procedures before you enter measurement parameters (such as frequency range).

- To connect an unknown signal
- To preset the analyzer
- To select the active channel
- To select the spectrum analyzer mode

To Connect an Unknown Signal

- Connect the unknown signal to the S input on the front panel.

The S input is a standard N 50 Ω female connector. If you want to connect the BNC cable, use the N-BNC adapter (furnished).

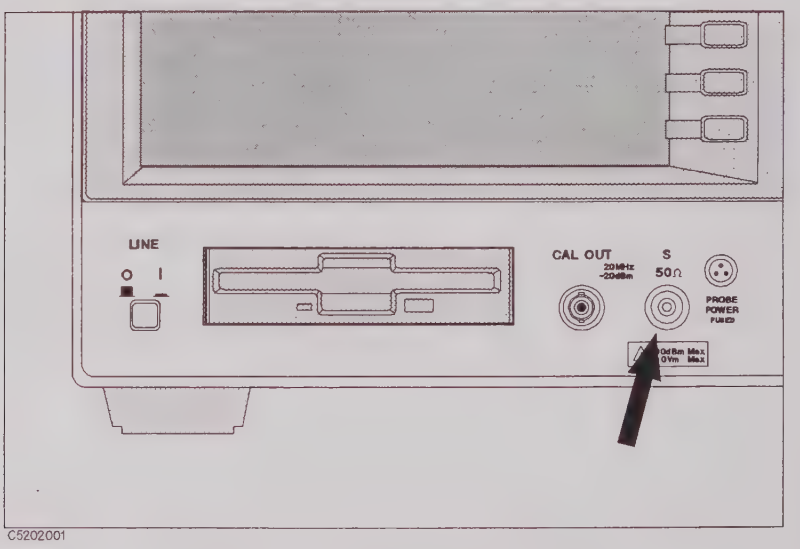

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Figure 2-1. Location of the S Input

To Preset the Analyzer

- In the INSTRUMENT STATE block, press the green Preset key to set the analyzer to the preset state.

For additional information about the preset state, see appendix D of the *Function Reference*.

To Select the Active Channel

- In the ACTIVE CHANNEL block, press (Ch 1) (channel 1) or (Ch 2) (channel 2) to toggle the active channel.

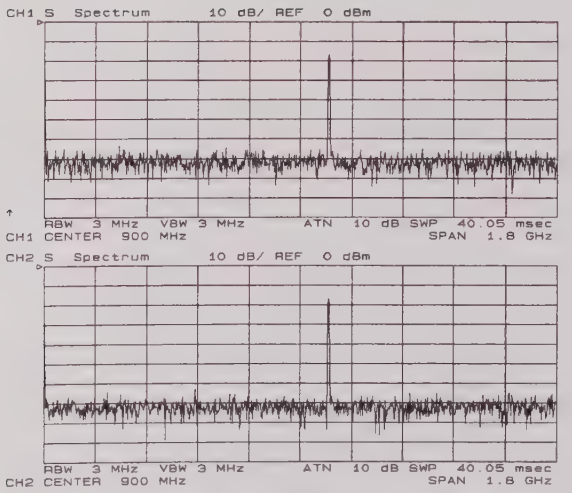
The analyzer has two independent channels. Each channel can have different settings that include whether the mode of operation is network analyzer or spectrum analyzer. Select the active channel before you select any other settings.

You can display two channels simultaneously.

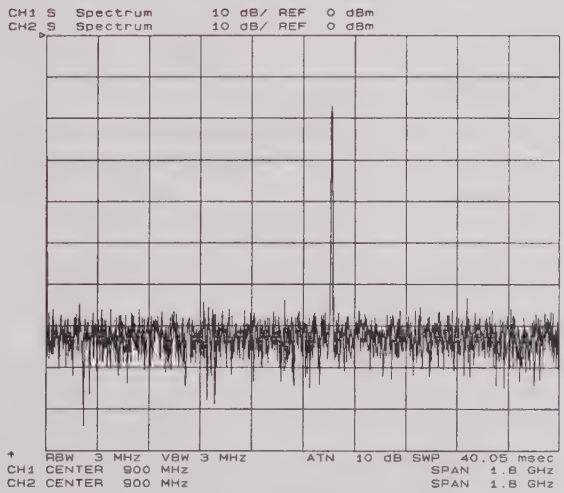
To Display Dual Channels

1. Press (Display).
2. Toggle `DUAL CHAN on OFF` to `ON off`.
3. Press `MORE`.
4. Select the following display modes:

Display Mode	Toggle
Split channel	`SPLIT CHAN on OFF` to `ON off`
Overlap channel	`SPLIT CHAN ON off` to `on OFF`


CH1 S Spectrum 10 dB/ REF 0 dBm
RBW 3 MHz VBW 3 MHz ATN 10 dB SWP 40.05 msec
CH1 CENTER 900 MHz SPAN 1.8 GHz
CH2 S Spectrum 10 dB/ REF 0 dBm
RBW 3 MHz VBW 3 MHz ATN 10 dB SWP 40.05 msec
CH2 CENTER 900 MHz SPAN 1.8 GHz

Toggle to `SPLIT DISP ON off`.


CH1 S Spectrum 10 dB/ REF 0 dBm
CH2 S Spectrum 10 dB/ REF 0 dBm
RBW 3 MHz VBW 3 MHz ATN 10 dB SWP 40.05 msec
CH1 CENTER 900 MHz SPAN 1.8 GHz
CH2 CENTER 900 MHz SPAN 1.8 GHz

Toggle to `SPLIT DISP on OFF`.

Figure 2-2. Dual Channel Display

To Select the Spectrum Analyzer Mode

1. Press (Meas).
2. Press ANALYZER TYPE, SPECTRUM ANALYZER.

When you change the analyzer type (mode), the analyzer is reset to a known state. So, you must select the analyzer type before you select any additional settings.

Step 2: Setting the Trigger

This step selects the trigger source and the sweep condition using the following procedures:

- To select the trigger mode
  - To use the external trigger
- To select the sweep condition

To Select the Trigger Mode

1. Press (Trigger).
2. Press TRIGGER:[FREE RUN] .
3. Select the trigger mode:

To Select a Trigger to	Press
Internal trigger source	FREE RUN
External trigger source	EXTERNAL [1]
Video trigger	VIDEO [2]
Manual	MANUAL
Time gated trigger	GATE [3]

1 See the "To Use the External Trigger" procedure.

2 The "To Stabilize the Trace Using the Video Trigger" in Chapter 3, describes how to use this trigger mode.

3 The "To Perform the Time Gated Spectrum Analysis" in Chapter 3, describes how to use this trigger mode. This function is option 1D6 only.

To Use the External Trigger

1. Connect the trigger source to the EXT TRIGGER connector on the rear panel of the analyzer.
2. Press (Trigger).
3. Press `TRIGGER:[FREE RUN]` .
4. Press `EXTERNAL` .
5. Input a trigger signal to the analyzer.

The external trigger signal must be TTL level compatible.

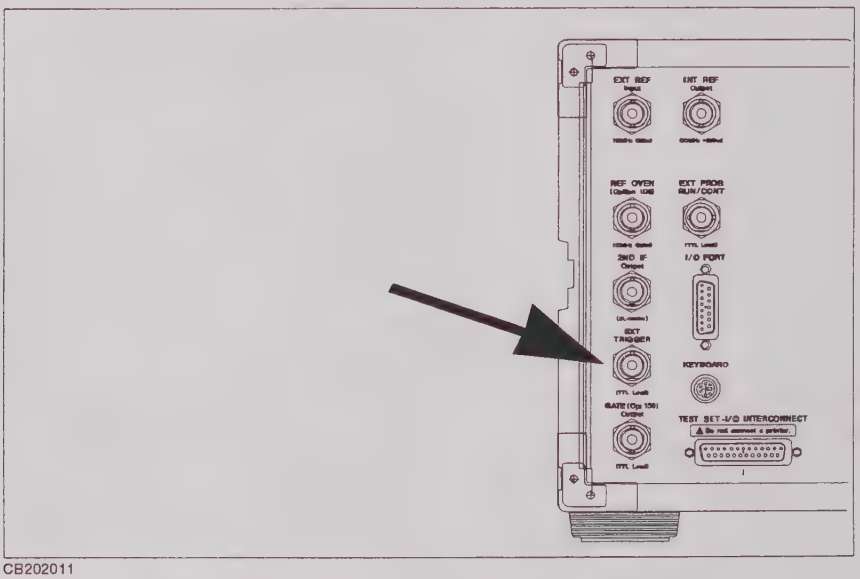


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Figure 2-3. Location of EXT TRIGGER Connector

To Set the Trigger Signal Polarity.

1. Press (Trigger).
2. Press `TRIGGER:[FREE RUN]` .
3. Toggle `TRIG PLRTY POS neg` to `pos NEG` to set the trigger signal polarity to negative.

To Select the Sweep Condition

1. Press Trigger.
2. Choose one of the following.

To Sweep	Do
Continuously	Press CONTINUOUS.
Single Time	Press SINGLE.
Specified Times	Press NUMBER of GROUPS. Then enter number of times to sweep.

Step 3: Selecting the Measurement Format

This step provides the following procedure:

- To select the display unit

To Select the Display Unit

1. Press (Format).
2. Select unit:

To Display	Unit	Press
Power	dBm	dBm
	W	WATT
Voltage	dBV	dBV
	dBμV	dBuV
	V	VOLT

You can change the displayed unit anytime you want. The analyzer calculates the unit conversion using the internal stored data. The sweep is not required (it can even be in the hold state).

Notes

For more information about each unit, see chapter 5 of the *Function Reference*.

If you want to make a noise measurement instead of a spectrum measurement, see "To Measure the Noise Level" in Chapter 3.

Step 4: Setting the Frequency Range

The analyzer has some useful commands for setting the frequency range. This step provides the following procedures that are related to setting the frequency range.

- To set the center frequency
  - To set the marker position to center
  - To set the maximum peak to center
  - To change the center with the specified step size
- To set the frequency span
  - To set the frequency range to full span
  - To narrow the span setting
- To zoom to a part of the trace
  - To change the zooming magnification
  - To display a zoomed trace on the other channel
  - To zoom between the marker and the Δmarker

To Set the Center Frequency

1. Press [Center] to activate the center frequency function.
2. Change the center frequency to place the target signal in the center of the grid by using the following keys:

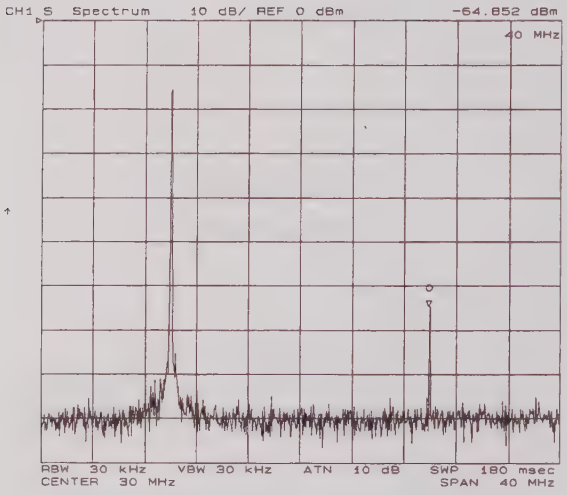
To	Use
Set directly	[0] ... [9] and units terminator keys
Change continuously	
Change with 1-2-5 steps[1]	[↑] [↓]

1 You can change the step size of [↑] [↓]. See "To Change the Center with the Specified Step Size" in this step.

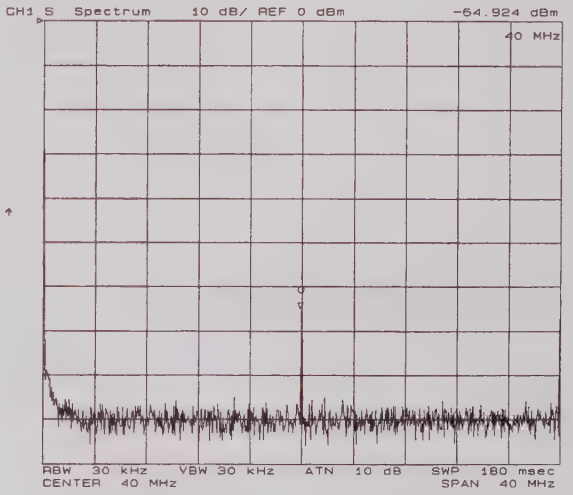
To Set the Marker Position to Center

1. Press (Marker→) to display the reverse-triangle shaped marker.
2. Place the marker on the position you want to set to the center by using the rotary knob.
3. Press MKR→CENTER.
4. Press (Entry Off).

The center frequency setting immediately changes to the marker position. If you are measuring an unknown signal, display the signal in full span first. Then move the signal to the center using this function.



Move the marker



Press MKR→CENTER

Figure 2-4. Marker to Center

To Set the Maximum Peak to Center

1. Press (Marker→).
2. Press PEAK→CENTER.
3. Press (Entry Off).

This function changes the center frequency to display the maximum peak in the center of the grid.

Note

When the frequency span setting is too wide, the peak cannot be placed in the center of the grid correctly. If the peak is not on the center of the grid, press PEAK→CENTER again.

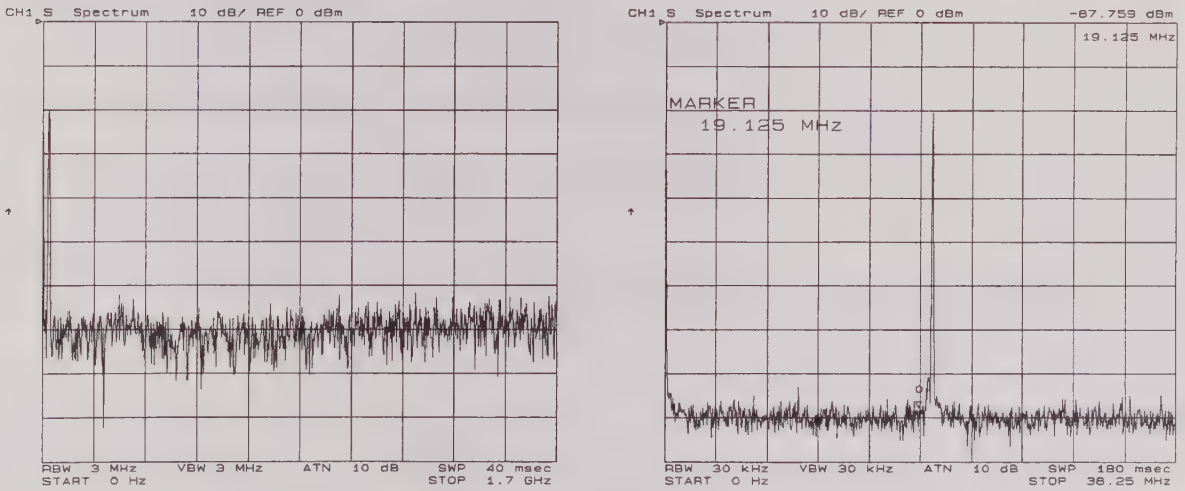

CH1 S Spectrum 10 dB/ REF 0 dBm
RBW 3 MHz VBW 3 MHz ATN 10 dB SWP 40 msec
START 0 Hz STOP 1.7 GHz
CH1 S Spectrum 10 dB/ REF 0 dBm -87.759 dBm
19.125 MHz
MARKER
19.125 MHz
RBW 30 kHz VBW 30 kHz ATN 10 dB SWP 180 msec
START 0 Hz STOP 38.25 MHz

Figure 2-5. Peak to Center

To Change the Center with the Specified Step Size

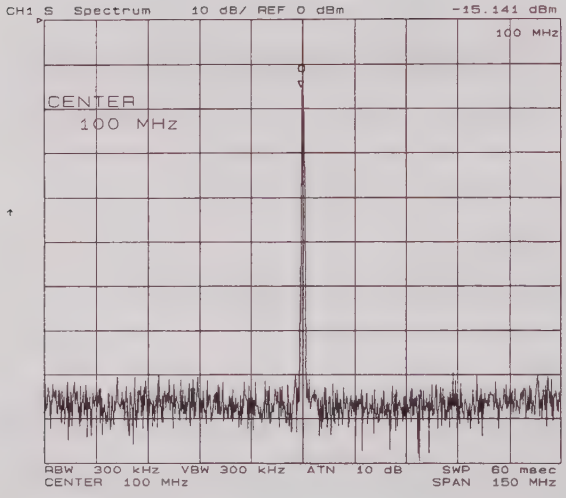
1. Press (Center).
2. Do one of the following:
   - Press CENTER STEP SIZE. Then set a step size directly by using (0) ... (9) and the units terminator keys.
   - Press (Marker). Move the marker to the point you want to use as the step size frequency. Then press (Center) MKR→CNTR STEP.
3. Toggle STEP SIZE AUTO man to auto MAN.
4. Press (Center).
5. Press (⇧) to increment (or (⇩) to decrement) the center frequency setting the specified step size.

This function is useful to display peaks that have a constant interval (such as a harmonics) one after the other. The following example shows how to display the harmonics using this function.

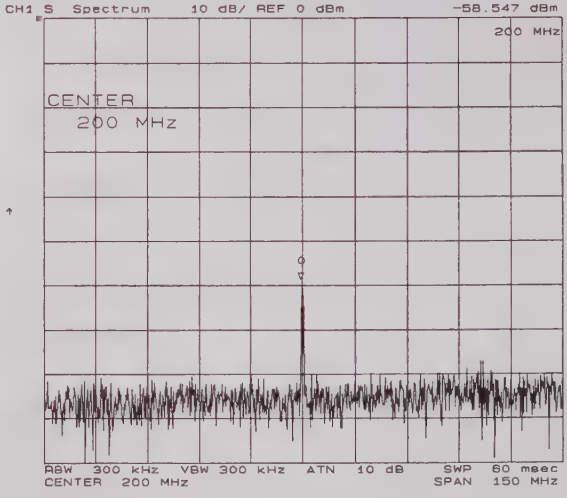
Example: Displaying Harmonics. When you want to display the fundamental and the harmonics of 100 MHz signal:

1. Press (Center) 100 (M/μ). Then set the span to display the fundamental in the center of the grid.
2. Press (Span) 150 (M/μ).
3. Toggle (Search) `SEARCH TRK on OFF` to `ON off` to enable the search track function.
4. Press `SEARCH:PEAK` to move the marker on the fundamental.
5. Press (Center) `MKR→CNTR STEP`. Enter 100 MHz (so the step size matches the fundamental frequency).
6. Toggle `STEP SIZE AUTO man` to `auto MAN` to enable the specified step size.
7. Press (Center). Then press (↑) to display the second harmonic.
8. To display higher order harmonics, press (↑) as required.

The marker searches for the next harmonic each time you change the center frequency by using the search track function.


CH1 S Spectrum 10 dB/ REF 0 dBm -15.141 dBm
100 MHz
CENTER
100 MHz
RBW 300 kHz VBW 300 kHz ATN 10 dB SWP 60 msec
CENTER 100 MHz SPAN 150 MHz

Fundamental


CH1 S Spectrum 10 dB/ REF 0 dBm -58.547 dBm
200 MHz
CENTER
200 MHz
RBW 300 kHz VBW 300 kHz ATN 10 dB SWP 60 msec
CENTER 200 MHz SPAN 150 MHz

Second Harmonics

Figure 2-6. Displaying Harmonics

To Set the Frequency Span

1. Press [Span].
2. Enter the frequency span to display the target peak in the optimum grid setting.

To	Use
Set directly	[0] ... [9] and units terminator keys
Change continuously	
Change with 1-2-5 steps	[↑] [↓]

To Set the Frequency Range to Full Span

1. Press [Span].
2. Press FULL SPAN

This function is useful when you want to get a general view of the spectrum after you have obtained the detailed view of a specific signal.

Notes You can set the sweep parameter using [Start] and [Stop] instead of [Center] and [Span]. See "To Set the Sweep Parameter Using [Start] and [Stop]" in Chapter 4.

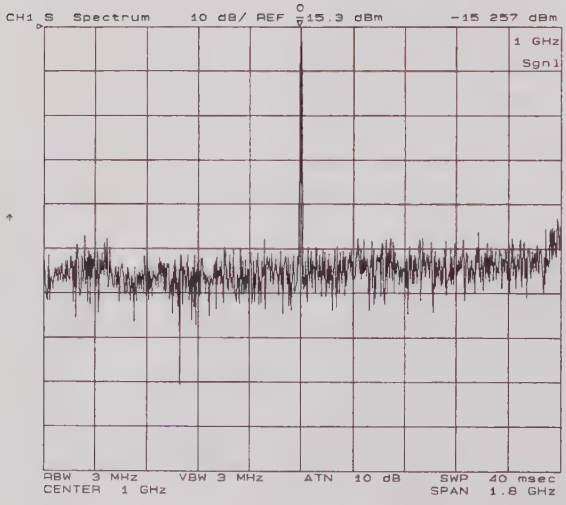
To Narrow the Span Setting

1. Press (Search).
2. Press SEARCH:PEAK to place the marker on the carrier.
3. Toggle SIGNAL TRK on OFF to ON off.
4. Narrow the span setting. See the "To Set the Frequency Span" procedure.

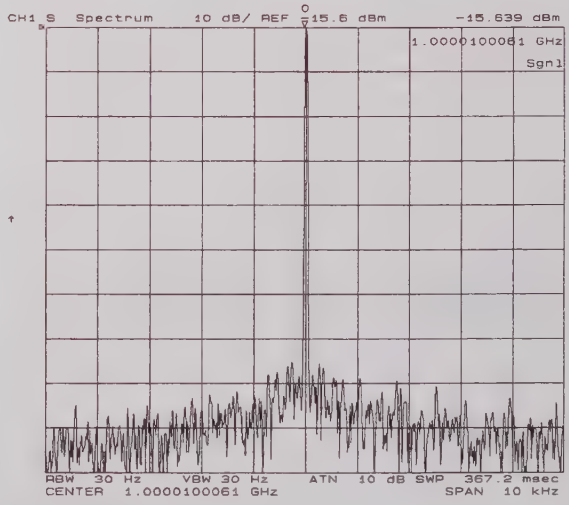
When you narrow the span setting substantially, the test signal can disappear from display. This happens because of the difference between the displayed and actual frequencies. For example, when the span setting is set to full span, the displayed test signal frequency has an error of approximately 2 MHz because of its resolution (1.8 GHz/800). If you narrow the span setting to less than the error frequency, the test signal can be lost from the display.

The signal track function allows you to avoid this situation. When signal track is enabled, the analyzer narrows the span setting while centering the test signal as you narrow the span setting. Therefore, the test signal is placed in the center of the grid.

The following figures show an example of narrowing the span with the signal track function. The actual signal frequency is 1.00001 GHz. When the center is fixed and the span is 10 kHz, the signal is out of display. The signal track function tracks the signal by changing the center frequency, and keeps displaying the signal in the center of the display.



Span 1.8 GHz


CH1 S Spectrum 10 dB/ REF 15.6 dBm -15.639 dBm
1.0000100061 GHz
Sgn1
RBW 30 Hz VBW 30 Hz ATN 10 dB SWP 367.2 msec
CENTER 1.0000100061 GHz SPAN 10 kHz

Span 10 kHz

Figure 2-7. Narrowing Span with Signal Track

To Zoom To a Part of the Trace

1. Move the marker to the point where you want to observe the signal details.
2. Press (Marker→).
3. Press MKR ZOOM.
4. To zoom more, press MKR ZOOM again.

To Change the Zooming Magnification

1. Press MORE ZOOMING APERTURE.
2. Enter a zooming aperture value as a percentage of the span.

If you want to magnify the display 20 times;, enter 5% for the zooming magnification.

To Display a Zoomed Trace on the Other Channel

1. Display two channels on the CRT. See the "To Display Dual Channels" procedure.
2. Toggle (Marker→) CROSS CHAN on OFF to ON off.
3. Press MKR ZOOM.

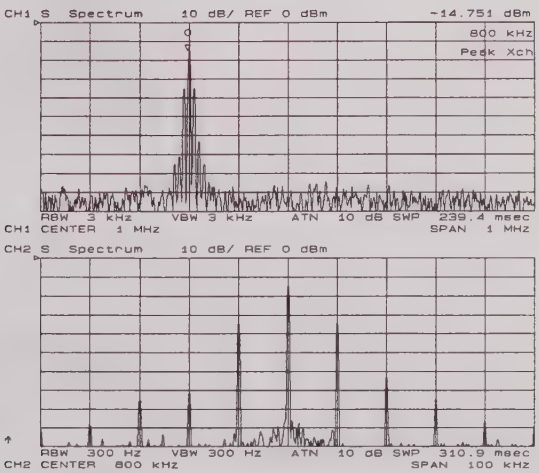

CH1 S Spectrum 10 dB/ REF 0 dBm -14.751 dBm
800 kHz
Peak Xch
RBW 3 kHz VBW 3 kHz ATN 10 dB SWP 239.4 msec
CH1 CENTER 1 MHz SPAN 1 MHz
CH2 S Spectrum 10 dB/ REF 0 dBm
RBW 300 Hz VBW 300 Hz ATN 10 dB SWP 310.9 msec
CH2 CENTER 800 kHz SPAN 100 kHz

Figure 2-8. Marker Zoom

To Zoom Between the Marker and the ΔMarker

1. Press (Marker).
2. Move the marker to the start point you want to zoom to by using the ⟲.
3. Press ΔMODE MENU ΔMKR.
4. Move the marker to the end point you want to zoom to by using the ⟲.
5. Press (Marker→) MORE.
6. Press MKRΔ→SPAN.

The center frequency and span setting are changed automatically to display the specified area. You can display the zooming result on the other channel by toggling CROSS CHAN on OFF to ON off.

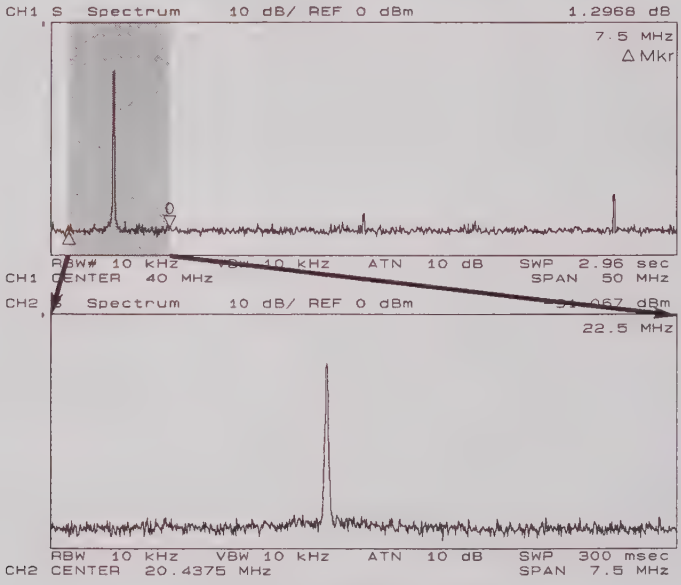

CH1 S Spectrum 10 dB/ REF 0 dBm 1.2968 dB
7.5 MHz
Δ Mkr
RBW# 10 kHz VBW 10 kHz ATN 10 dB SWP 2.96 sec
CH1 CENTER 40 MHz SPAN 50 MHz
CH2 S Spectrum 10 dB/ REF 0 dBm
22.5 MHz
RBW 10 kHz VBW 10 kHz ATN 10 dB SWP 300 msec
CH2 CENTER 20.4375 MHz SPAN 7.5 MHz

Figure 2-9. MKRΔ→SPAN

Step 5: Setting the Vertical Settings

You need to change the vertical settings if the top of peak is out of the grid or a signal level is too small relative to a reference setting. To change the vertical settings, change the reference value or spread the display area by changing the scale per division setting by doing one of the following procedures:

- To set the reference level
- To change the scale per division

To Set the Reference Level

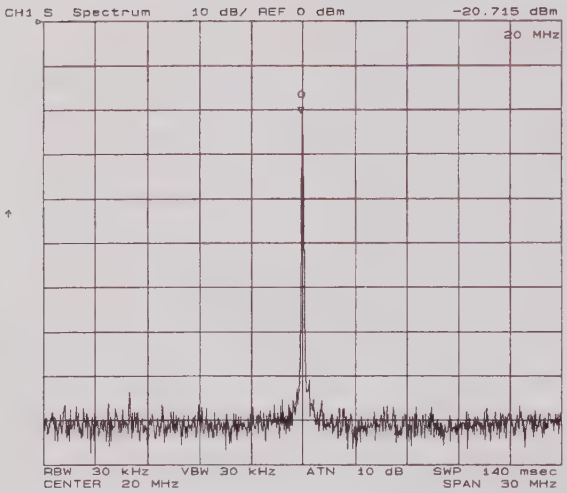
Using the Entry Keys

1. Press (Scale Ref).
2. Press REFERENCE VALUE.

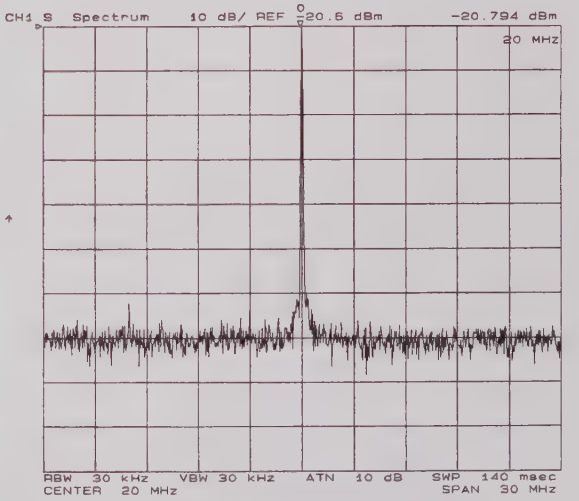
To	Use
Move trace toward top	or ↓
Move trace toward bottom	or ↑
Set reference value directly	0 ... 9 and unit keys

Using the Marker

1. Press (Search) SEARCH:PEAK to move the marker to the peak.
2. Press (Scale Ref).
3. Press MKR→REFERENCE.



Move the marker to the top of the peak



Press (Scale Ref) MKR→REFERENCE

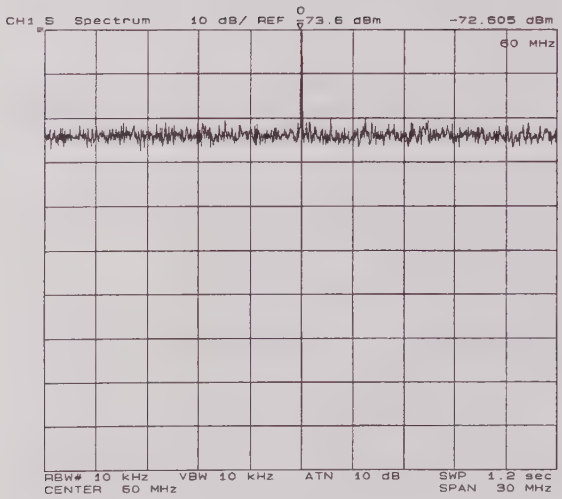
Figure 2-10. Marker to Reference

To Change the Scale per Division

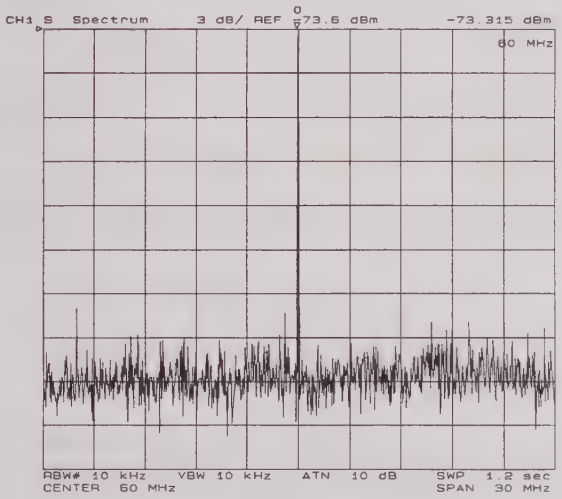
1. Set the reference level to the peak level of the target signal. See the "To Set the Reference Level" procedure.
2. Press (Scale Ref).
3. Press SCALE/DIV.
4. Change the scale/division setting to display additional details by using following keys:

To	Use
Change continuously	
Change 1-2-5 steps	
Set Scale/Div directly	0 ... 9 and unit keys

This function can be used to display a small peak on a full grid.



Scale 10 dB/Div



Scale 3 dB/Div

Figure 2-11. Changing Scale/Div.

Step 6: Tuning the Settings

This step provides the bandwidth settings. The RBW setting affects the resolution of the frequency and lowers the displayed noise floor. The video bandwidth setting reduces noise variation.

- To set the resolution bandwidth (RBW)
- To set the video bandwidth
- To minimize the sweep time

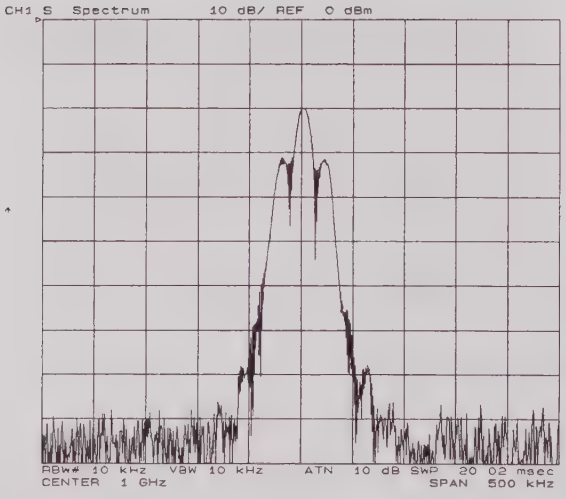
To Set the Resolution Bandwidth (RBW)

1. Press (Bw/Avg).
2. Change the RBW setting by using ⇧, ⇩, or the knob.

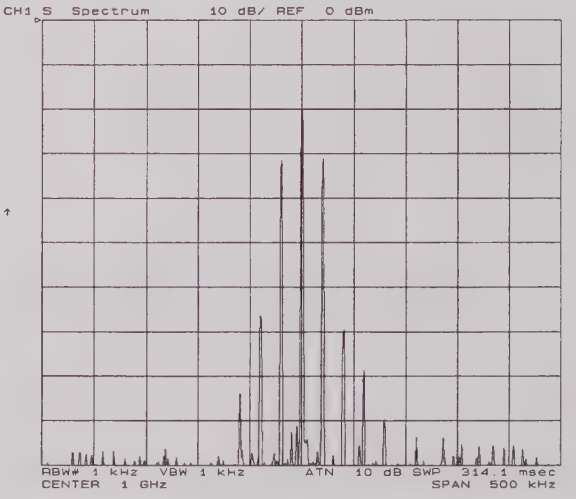
If the internal IF filter is wider than the difference of the adjacent signals, the analyzer cannot separate them. You must set the Resolution Bandwidth (RBW) narrower to make sure the analyzer can recognize each signal. For more information about RBW, see the *Function Reference*.

Narrowing the RBW reduces the noise power per display point. As a result, the displayed noise floor is down and the lower level signal is displayed.

For example, the trace of a 20 kHz amplitude modulated signal conceals sidebands in the skirt of the carrier trace when the RBW is 10 kHz. If you set the RBW to 1 kHz, the carrier and sidebands are split completely and the displayed noise floor is down.



RBW 30 kHz



RBW 1 kHz

Figure 2-12. Setting Resolution Bandwidth (RBW)

To Set the Video Bandwidth

1. Press (Bw/Avg).
2. Press VIDEO BW .
3. Set video bandwidth by using the following keys:

To	Use
Lower noise level	↓, or
Faster sweep time	↑, or
Set bandwidth directly	0 . . . 9 and unit keys

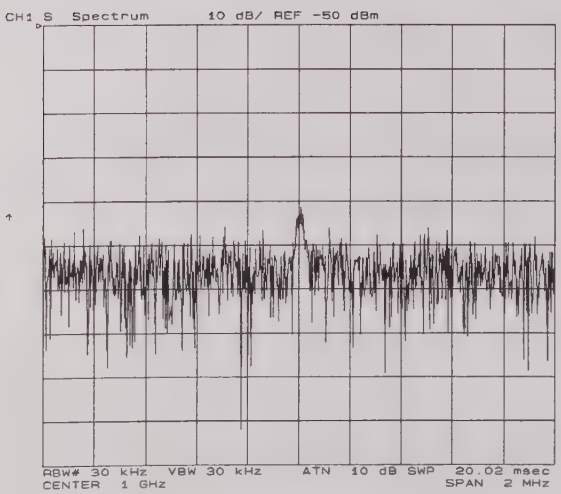
When the target signal and the noise are hard to distinguish because of noise variation, narrow the video bandwidth. This reduces the noise variations and makes the signal clearly visible. However, if the video bandwidth is narrowed, the sweep takes more time.

The allowable VBW setting is 1/1, 1/3, 1/10, 1/30, 1/100, and 1/300 of the current RBW setting.

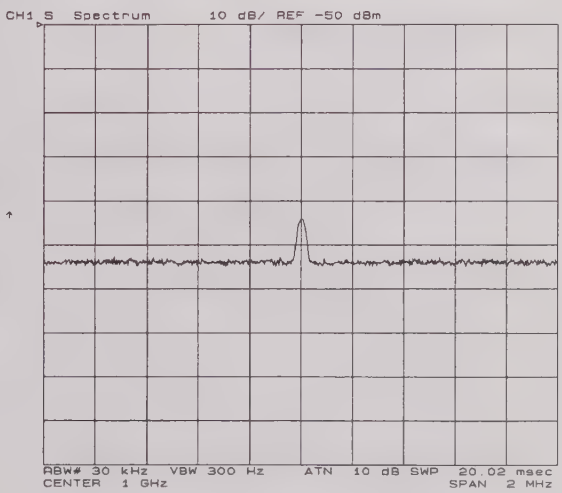
To Turn Off the Video Bandwidth

1. Press (Bw/Avg) VIDEO BW .
2. Enter the same value as the RBW setting.

For more information about the VBW, see chapter 12 of the *Function Reference* manual.



Video BW 10 kHz



Video BW 300 Hz

Figure 2-13. Setting Video Bandwidth (VBW)

To Minimize the Sweep Time

1. Press (Sweep).
2. Press SWEEP TIME.
3. Press (0) (x1).

The analyzer reduces the NOP (number of points) to equalize the display resolution and the RBW. As a result, the displayed trace becomes rough. However, the frequency readout resolution does not change.

This feature is effective when the RBW is greater than Span/(NOP−1). For more information about this feature, see chapter 6 of the *Function Reference* manual.

Figure 2-14 shows an example of minimizing the sweep time. Center, span, VBW, and RBW settings are the same, but the sweep time that is shown on the right bottom of each trace is different. The sweep time of channel 2 is approximately 25% of channel 1.

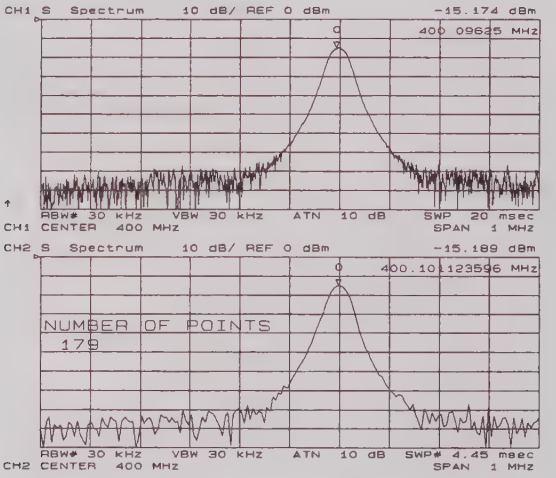

CH1 S Spectrum 10 dB/ REF 0 dBm -15.174 dBm
400 09635 MHz
RBW# 30 kHz VBW 30 kHz ATN 10 dB SWP 20 msec
CH1 CENTER 400 MHz SPAN 1 MHz
CH2 S Spectrum 10 dB/ REF 0 dBm -15.189 dBm
400.10123596 MHz
NUMBER OF POINTS
179
RBW# 30 kHz VBW 30 kHz ATN 10 dB SWP# 4.45 msec
CH2 CENTER 400 MHz SPAN 1 MHz

Figure 2-14. Minimized Sweep Time

Step 7: Performing Calibration

This step provides procedures for the reference level calibration. Performing the reference level calibration improves the level accuracy.

- To perform the reference level calibration
- To use the external reference
- To turn off the calibration

To Perform the Reference Level Calibration

1. Wait at least 30 minutes after the analyzer is turned on. This warming up period is required to meet the analyzer's specifications.
2. Attach the N(m)-BNC(f) adapter (furnished) to an input (S, R, A, or B). (See Figure 2-15.)
3. Connect the CAL OUT output and the selected input using the BNC cable (furnished).
4. Press (Meas). Then select the input (that the cable is connected to) by pressing `S`, `R`, `A` or `B`.
5. Press (Cal).
6. Press `EXECUTE LVL CAL`.

The analyzer automatically changes the frequency setting to measure the CAL OUT signal. When the reference level calibration is completed, all measurement settings are restored.

After the calibration is completed, "`Cor`" appears on the left side of the grid.

To obtain a higher level measurement accuracy, perform the reference level calibration just before reading the measured value. If you change the setting of the RBW or the attenuator, you must perform the reference level calibration again. The analyzer stores the calibration data individually for each of the inputs.

The error terms that are canceled by the reference level calibration are described in chapter 12 of the *Function Reference* manual.

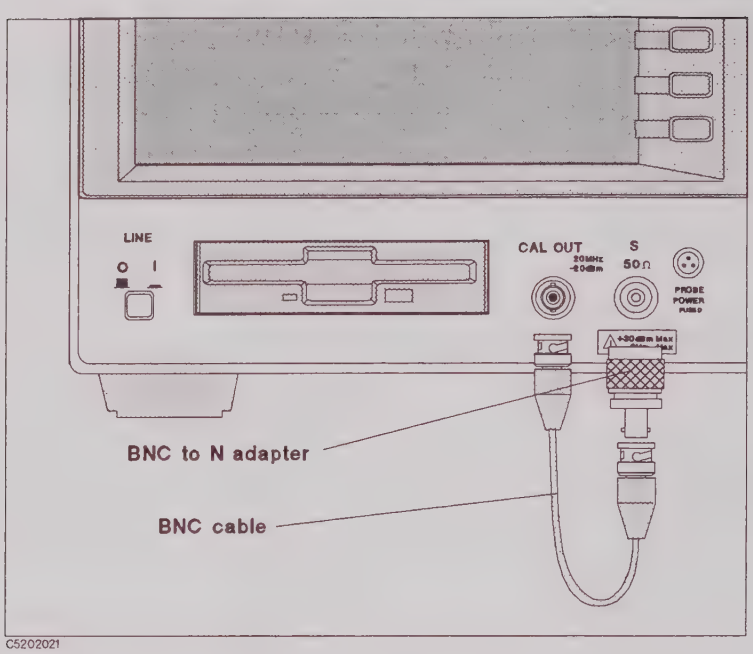


Figure 2-15. Reference Level Calibration Connection

To Use the External Reference

You can use an external reference signal instead of the internal reference.

1. Wait at least 30 minutes after the analyzer is turned on. This warming up period is required to meet the analyzer's specifications.
2. Connect the external reference to the selected front-panel spectrum input.
3. Set up the frequency range to measure the external reference signal.
4. If a unit other than dBm is selected, press (Format) dBm .
5. Press (Search) SEARCH:PEAK . Then move the marker to the peak of the external reference signal.
6. Read the external reference signal level.
7. Calculate the *expected level – readout level* of the reference signal.
8. Press (Cal) LVL CAL DATA . Then enter the calculated value.

To Turn Off Calibration

1. Press (Cal)
2. Press LVL CAL DATA. Then press (0) (×1)

The "Cor" notation disappears from the display.

To Perform the Calibration for the 75 Ω Configuration

If you want to perform a reference level calibration in the 75 Ω configuration:

1. If the analyzer is not set up for a 75 Ω configuration, see appendix A of the *User's Guide*.
2. Confirm that the analyzer is configured to measure the 75 Ω configuration by pressing (Cal) INPUT Z.
3. Wait at least 30 minutes after the analyzer is turned on. This warming up period is required to meet the analyzer's specifications.
4. Attach the 75 Ω N(m) to 50 Ω BNC(f) adapter to the HP 11852B option C04 50 Ω(m)/75 Ω(f) minimum loss pad that is connected to the S input. (See Figure 2-16.)
5. Connect the CAL OUT and the S input with the 50 Ω BNC cable.
6. Press EXECUTE LVL CAL.
7. After the completion of calibration, disconnect the BNC cable.
8. Detach the 75 Ω N(m) to 50 Ω BNC(f) adapter.

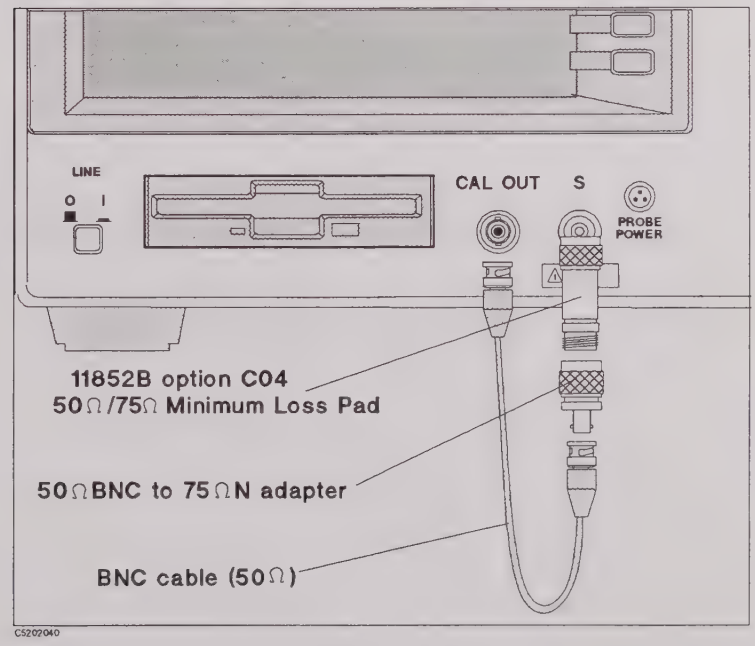


Figure 2-16.
Reference Level Calibration Connection for the 75 Ω Configuration

Step 8: Reading the Measured Result

If you can display the correct trace on the display, you can read the measured signal level using the marker. The analyzer has several useful search functions. This step provides the procedures for reading the measured results using the marker.

- To read a value using the marker
- To stabilize the trace
- To use the sub-markers
- To use the Δmarker
- To search for a single peak on the trace
- To search for multiple peaks
- To ignore small peaks

To Read a Value Using the Marker

1. Press (Marker).
2. Move the marker by performing the following steps:
   - Turn the rotary knob until the marker moves to the point where you want to read the measured value.
   - Enter the target frequency by using numerical keys.
3. Read the marker value displayed on the upper right of the display.

If you want a more accurate frequency reading of the target signal, set the span and the RBW as narrow as possible.

Note

The readout resolution of the frequency is determined by the setting of the frequency span, the number of points (NOP), and the resolution bandwidth (RBW). The resolution is the larger value between SPAN/(NOP−1) and RBW. For example, when the frequency span is 10 MHz, the NOP is 801, and the RBW is 10 kHz, the readout resolution is approximately 12.5 kHz.

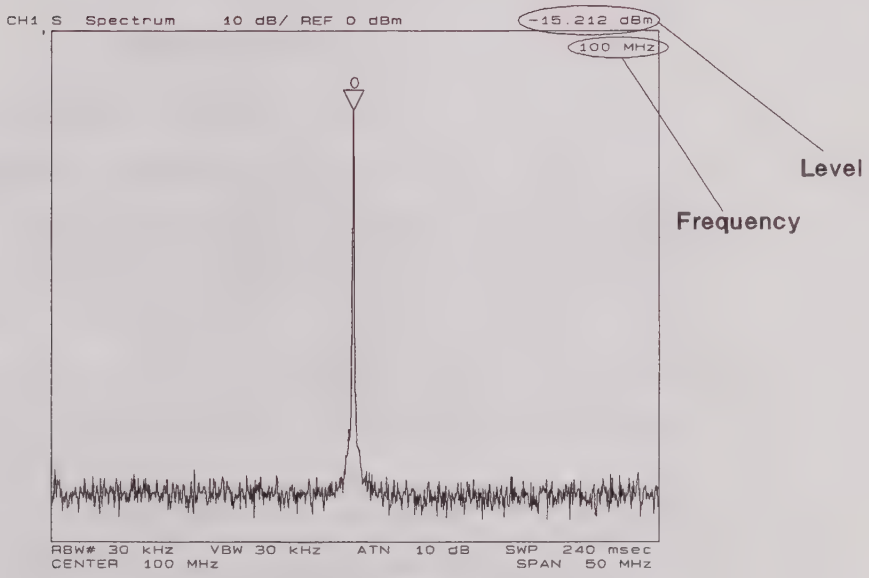

CH1 S Spectrum 10 dB/ REF 0 dBm
-15.212 dBm
100 MHz
0
Level
Frequency
RBW# 30 kHz VBW 30 kHz ATN 10 dB SWP 240 msec
CENTER 100 MHz SPAN 50 MHz

Figure 2-17. Marker Readout

To Stabilize the Trace

When the trace is not stable and the marker value changes frequently, it is difficult to read the measured value. You can use the following techniques to stabilize the trace:

- Stop the sweep.
- Use the averaging function.
- Use the maximum or minimum hold function.
- Capture the unstable signal using signal track.

To Stop the Sweep

1. Press (Trigger).
2. Press SWEEP: HOLD.

The sweep is stopped immediately (even if the sweep is in progress). If you want to restart the sweep, press CONTINUOUS to start a free-run sweep or press SINGLE to make a single sweep.

To Use the Averaging Function

1. Press (Bw/Avg).
2. Press AVERAGING FACTOR.
3. If needed, enter the averaging factor (number of times). Then press the (x1). Default averaging factor is 16.
4. Toggle AVERAGING on OFF to ON off.

The averaging notation (Avg) appears on left side of the grid when averaging is turned on. The averaging notation indicates the number of times averaging has been performed. When averaging is completed, the counter stops incrementing. However, the trace continues updating with each sweep.

Averaging requires a sweep with a specified number of times that is enough for an averaging factor to complete the averaging. You can set the number of sweeps by using the number of groups function.

If you want to change the setting of any parameter when averaging, you can restart averaging from the 0 count.

To restart the averaging, press (Bw/Avg) AVERAGING RESTART. This resets averaging counter to 0.

To Use Maximum or Minimum Hold Function

1. Press (Display).
2. Press DATA HOLD [OFF].

To Hold	Press
Maximum Level	MAX
Minimum Level	MIN

"Max" (or "Min") appears on the right of the grid when the maximum (minimum) hold function is activated.

To turn off the maximum or minimum hold, press (Display) DATA HOLD [MAX] HOLD: OFF.

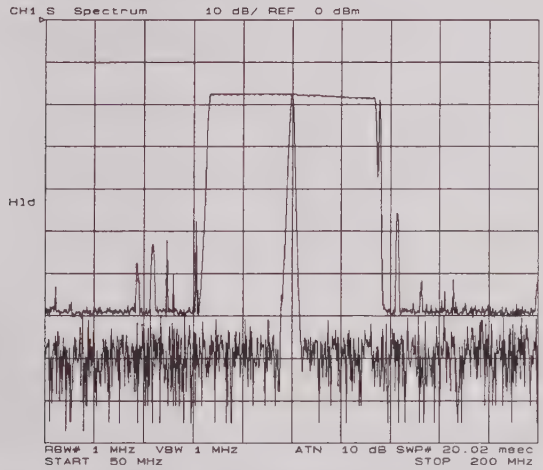


Figure 2-18. Maximum Holding the Drifting Signal

To Capture an Unstable Signal Using Signal Track

1. Press (Search).
2. Press SEARCH:PEAK to move the marker to the peak of the drifting test signal.
3. Toggle SIGNAL TRK on OFF to ON off.

The signal track function captures the peak that is indicated by the marker and places it in the center of the grid for each sweep. If the peak is unstable horizontally, use this function. The analyzer automatically changes the center frequency to keep the peak in the center of the grid.

To Use the Sub-markers

1. Press (Marker).
2. Move the marker to the point where you want to set the sub-marker.
3. Press SUB MKR.
4. Select the sub-marker from SUB MKR 1 to 7.
5. Press (Utility).
6. Toggle MKR LIST on OFF to ON off to display the marker list on the bottom of the display.

The sub-marker appears at the point of that the marker is displayed. Sub-markers are fixed horizontally and you cannot move them.

The sub-marker value can only be displayed by using the marker list.

To clear a sub-marker, press (Marker) CLEAR SUB MKR. Then press the sub-marker number that you want to erase from the display.

To clear all of the markers, press (Marker) PRESET MKRS.

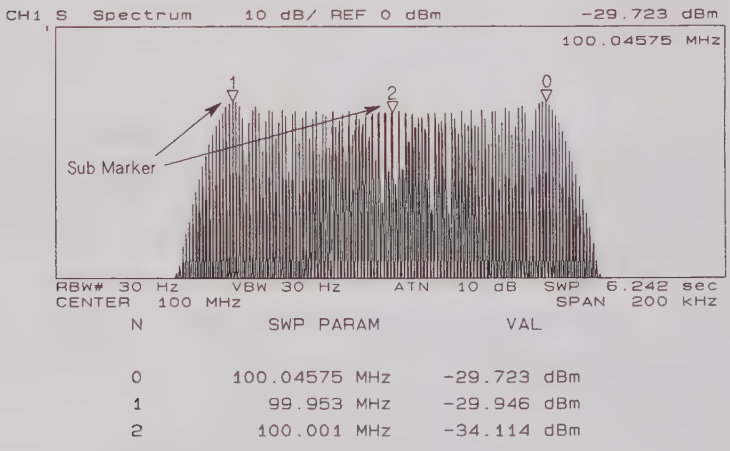

CH1 S Spectrum 10 dB/ REF 0 dBm -29.723 dBm
100.04575 MHz
1
2
0
Sub Marker
RBW# 30 Hz VBW 30 Hz ATN 10 dB SWP 6.242 sec
CENTER 100 MHz SPAN 200 kHz
N SWP PARAM VAL
0 100.04575 MHz -29.723 dBm
1 99.953 MHz -29.946 dBm
2 100.001 MHz -34.114 dBm

Figure 2-19. Sub-marker and Maker List

To Use the ΔMarker

1. Press (Marker).
2. Place the marker at the point you want use as the reference point by using the .
3. Press ΔMODE MENU.
4. Press ΔMKR.
5. The reference marker appears at the marker point.
6. To move the marker:
   - Enter an offset frequency by using the numerical keys.
   - Turn the rotary knob until the marker moves to the point you want to read the value.
7. Read the level and the frequency differences from the reference marker that are displayed on the upper right of the grid.

The marker value on the upper right of the grid shows the frequency and the level differences between the reference marker and the marker.

When you use the sub-markers, use the marker list to display the difference between reference the marker and the sub-markers.

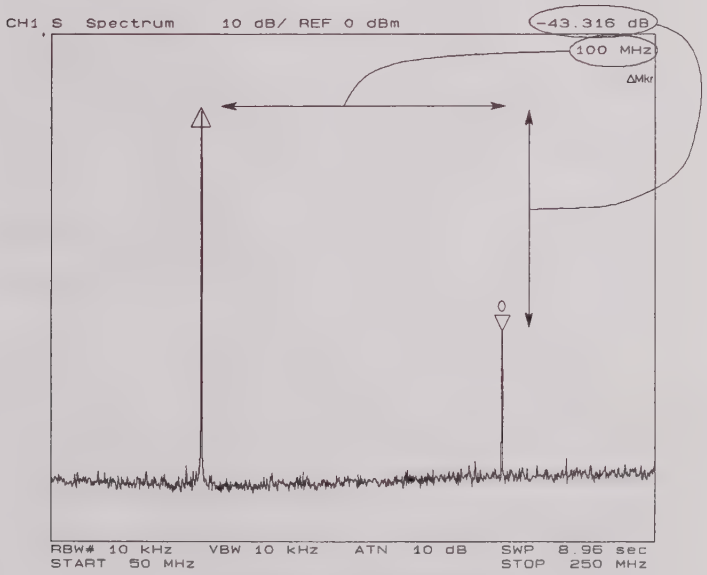


Figure 2-20. ΔMarker

To Search For a Single Peak on the Trace

1. Press (Search).
2. Press SEARCH:PEAK to search a maximum peak.
3. If you want to search for another peak:

To search next peak for	Press
2nd highest peak	NEXT PEAK
Peak just to the left	NEXT PEAK LEFT
Peak just to the right	NEXT PEAK RIGHT

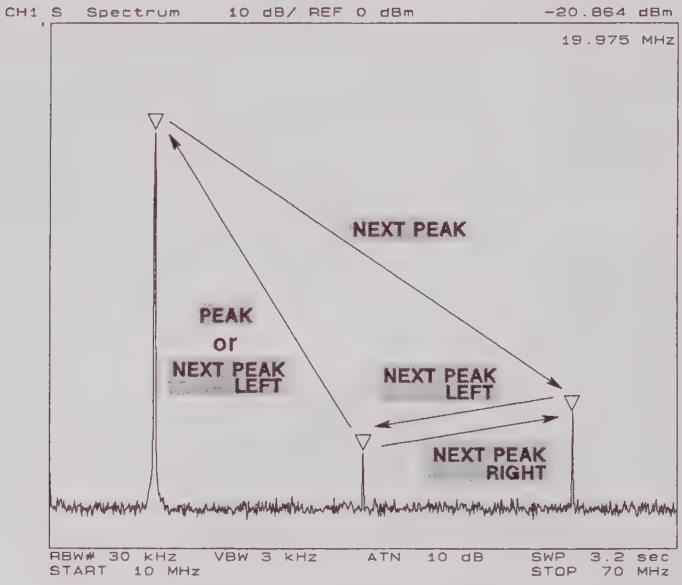


Figure 2-21. Peak Search

To Search For Multiple Peaks

1. Press (Search) MULTIPLE PEAKS .
2. Do any of following:

To search for peaks	Press
For the all peaks	SEARCH: PEAKS ALL
For peaks on the right	PEAKS RIGHT
For peaks on the left	PEAKS LEFT

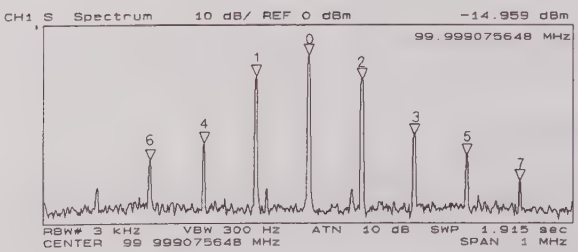
3. Press (Utility). Toggle MKR LIST on OFF to ON off to list all marker values.

When this function is enabled, the marker is placed on the maximum peak and the sub-markers are placed on up to seven other peaks. PEAKS ALL searches for all the peaks and places the sub-markers in the order of peak level.

PEAKS RIGHT and PEAKS LEFT search only to the right or left side of the peak and place the sub-markers on peaks in the order found.

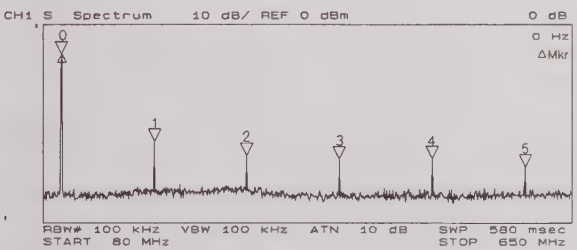
If the frequency of the carrier is unstable, use the search track function by toggling (Search) SEARCH TRK on OFF to ON off . The analyzer searches for the peaks each sweep to capture the shifted carrier and any harmonics or sidebands.

If the marker is to search for peaks other than harmonics, specify the peak threshold for the search function. This makes the search function ignore the peaks that have a lower level than the threshold level. See the "To Ignore Small Peaks" procedure.


CH1 S Spectrum 10 dB/ REF 0 dBm -14.959 dBm
99.999075648 MHz
RBW# 3 kHz VBW 300 Hz ATN 10 dB SWP 1.915 sec
CENTER 99.999075648 MHz SPAN 1 MHz

N	SWP PARAM	VAL
0	99.999075648 MHz	-14.959 dBm
1	99.899075648 MHz	-26.508 dBm
2	100.099075648 MHz	-26.67 dBm
3	100.199075648 MHz	-54.55 dBm
4	99.800325648 MHz	-59.704 dBm
5	100.297825648 MHz	-65.179 dBm
6	99.700325648 MHz	-68.484 dBm
7	100.397825648 MHz	-78.953 dBm

PEAKS:ALL



N	SWP PARAM	VAL
0	0 Hz	0 dB
1	99.75 MHz	-43.599 dB
2	199.5 MHz	-51.512 dB
3	299.9625 MHz	-53.796 dB
4	399.7125 MHz	-51.908 dB
5	499.4625 MHz	-57.11 dB
Δ	99.95 MHz	-15.104 dBm

PEAKS RIGHT with Δmarker

Figure 2-22. Searching for Multiple Peaks

To Specify the Search Range

You can set the search function to search within a specified range. To specify the search range, use one of the following two procedures:

- Using the marker
- Using the Δmarker

Using the Marker

1. Press (Search).
2. Press SEARCH RANGE MENU .
3. Toggle PART SRCH on OFF to ON off .
4. Move the marker to the start point of the search range.
5. Press MKR→LEFT RNG to set the marker position as the left edge of the range.
6. Move the marker to the end point of the search range.
7. Press MKR→RIGHT RNG to set the marker position to the right edge of the range.
8. Press RETURN

Using the ΔMarker

1. Press (Marker).
2. Move the marker to the start point of the search range.
3. Press ΔMODE MENU .
4. Press ΔMKR .
5. Move the marker to the end point of the search range.
6. Press (Search).
7. Press SEARCH RANGE MENU .
8. Toggle PART SRCH on OFF to ON off to enable the search range.
9. Press MKRΔ→SEARCH RNG .

All the search functions search within a specified search range. You can specify the search range for each channel individually. The triangle-shaped indicator at the bottom of the grid shows the current search range (see Figure 2-23). In this figure, PEAK searches for the highest peak within the specified range. It does not search all of the grid.

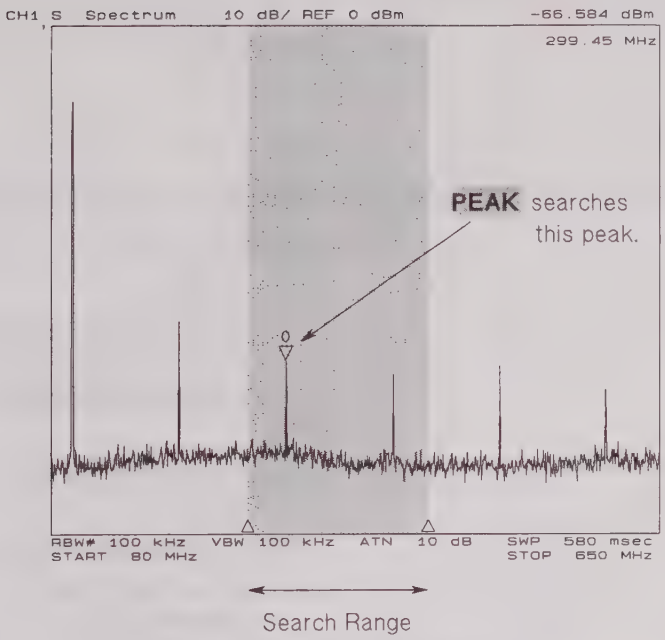

CH1 S Spectrum 10 dB/ REF 0 dBm
-66.584 dBm
299.45 MHz
PEAK searches this peak.
RBW# 100 kHz VBW 100 kHz ATN 10 dB SWP 580 msec
START 80 MHz STOP 650 MHz
Search Range

Figure 2-23. Search Range

To turn off the part search, toggle `PART SRCH ON off` to `on OFF`.

To Ignore Small Peaks

You can set the search function to ignore small peaks (such as noise) by defining the peak. The analyzer accept the following two types of peak definition.

- Peak threshold
- Peak height

Defining the Peak Threshold

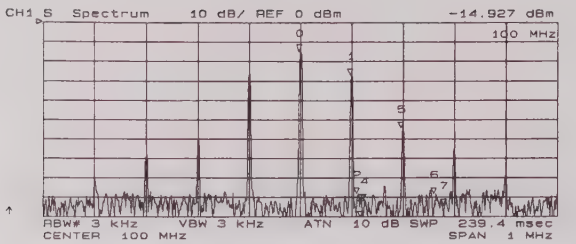
Using Rotary Knob.

1. Press (Search).
2. Press SEARCH:PEAK PEAK DEF MENU.
3. Toggle THRESHOLD on OFF to ON off to display the red threshold line.
4. Press THRESHOLD VALUE. Then set the threshold value using the following:
   - Enter the threshold value using numerical keys.
   - Turn the rotary knob to move the threshold line to the appropriate position.
5. Press RETURN

Using the Marker.

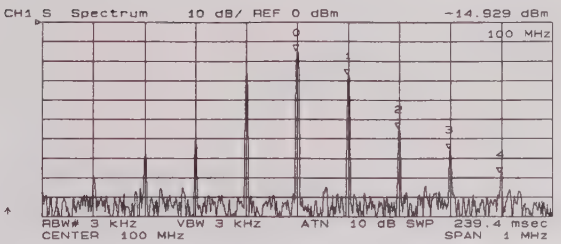
1. Press (Search) SEARCH:PEAK.
2. Move the marker to the point you want to set as a threshold value.
3. Press PEAK DEF MENU MKR→THRESHOLD.
4. Toggle THRESHOLD on OFF to ON off.
5. Press RETURN

When the peak threshold is activated, the red threshold line is displayed. The marker search function searches only for peaks above the threshold line.



N	SWP PARAM	VAL
0	100 MHz	-14.927 dBm
1	100.1 MHz	-26.663 dBm
2	100.1125 MHz	-88.291 dBm
3	100.12 MHz	-102.9 dBm
4	100.12625 MHz	-91.205 dBm
5	100.19875 MHz	-54.369 dBm
6	100.2625 MHz	-88.342 dBm
7	100.28125 MHz	-93.883 dBm

Before Defining the Threshold



N	SWP PARAM	VAL
0	100 MHz	-14.929 dBm
1	100.1 MHz	-26.659 dBm
2	100.2 MHz	-54.384 dBm
3	100.29875 MHz	-64.949 dBm
4	100.39875 MHz	-77.542 dBm

After Defining the Threshold

Figure 2-24. Threshold Function

Defining Peak Height

1. Press (Search).
2. Press SEARCH:PEAK PEAK DEF MENU.
3. Press PEAK DEF: ΔY.
4. Enter a peak height using the numerical keys and the units terminator keys.
5. Press RETURN.

For more information about peak definition, see chapter 12 of the *Function Reference* manual.

3

Typical Spectrum Measurement Techniques

This chapter describes typical measurement techniques using the spectrum analyzer mode of operation.

The measurement techniques described in this chapter are as follows:

- To measure the noise level
- To measure the carrier to noise ratio
- To perform the time gated spectrum analysis
- To measure zero span (time domain measurement)
- To track unstable harmonics using search track
- To track and zoom a signal

To Measure the Noise Level

1. Press (Format).
2. Press NOISE.
3. Press (Scale Ref). Then press (⇩) until the noise trace closes to the reference level.
4. Press (Bw/Avg). Then press VIDEO BW.
5. Press (⇩) to flatten the noise trace.
6. Press (Marker). Then turn the and read the normalized noise level.

The marker readout unit becomes "dBm/Hz" and is normalized by the 1 Hz equivalent noise bandwidth (ENBW). To convert the ENBW, see the "To Convert to a Different Equivalent Noise Bandwidth" procedure.

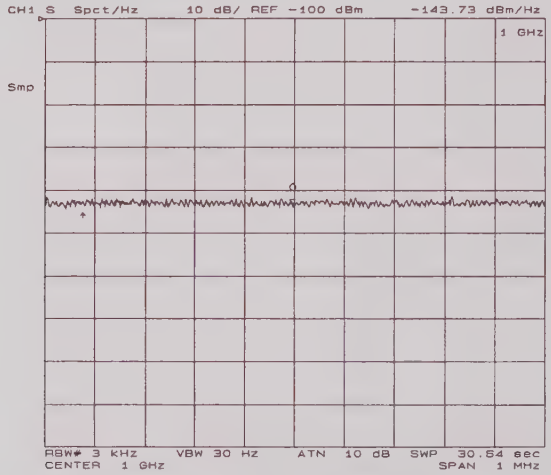


Figure 3-1. Noise Readout

Note

When you change the format to a noise format, the analyzer changes the detection mode to sample detection. If you return the format to SPECTRUM, the detection mode automatically is set to the positive peak detection mode. This happens even if you selected the negative detection mode before changing to the noise format.

To Convert to a Different Equivalent Noise Bandwidth

1. Calculate the conversion factor by using the following equations with displayed units:

Unit	Use
dBm/Hz	$K = 10\log\frac{BW}{1}$
dBV/Hz and dBμV/Hz	$K = 20\log\frac{BW}{1}$
V/Hz and W/Hz	$K = BW$

   Where, *BW* is the different equivalent noise bandwidth.

2. Press (Display) DATA MATH.
   - Press OFFSET for dBm/Hz, dBV/Hz, and dBμV/Hz.
   - Press GAIN for V/Hz and W/Hz.
3. Enter *K*, then press (×1).

To Measure the Carrier to Noise Ratio

1. Set up the frequency range to measure a carrier signal.
2. Press (Search) SEARCH:PEAK to place the marker on the carrier signal.
3. Press (Scale Ref) MKR→REFERENCE to set the reference level to the carrier signal level.
4. Adjust the scale/div to display the carrier and noise floor. Use (Scale Ref) SCALE/DIV.
5. Press (Marker) ΔMODE MENU ΔMKR to place the reference marker on the carrier signal.
6. Press (Bw/Avg). Then press VIDEO BW.
7. Enter an appropriate video bandwidth to reduce the variation.
8. Press (Marker). Then do either of the following:
   - Enter the offset frequency by using the numeric keys.
   - Move the marker into the noise level of the trace by using the rotary knob.
9. If you want to normalize the marker readout with the RBW filter, press (Utility) and toggle NOISE FORM on OFF to ON off.
10. Read the difference from the reference marker.

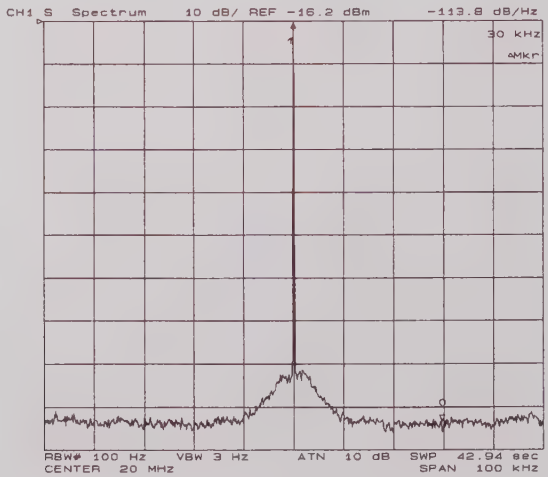


Figure 3-2. C/N Measurement

To Perform the Time Gated Spectrum Analysis

Do the following steps to perform a time gated spectrum analysis:

1. Determining Gate Trigger Parameters
2. Gate Trigger Source Connection
3. Setting Center and Span Frequency
4. Adjusting Gate Trigger
5. Setting RBW, VBW, and Averaging
6. Measuring

Note This function is only available with the option 1D6.

Step 1: Determining Gate Trigger Parameters

1. Connect the target signal and the trigger signal to an oscilloscope input (see Figure 3-3).

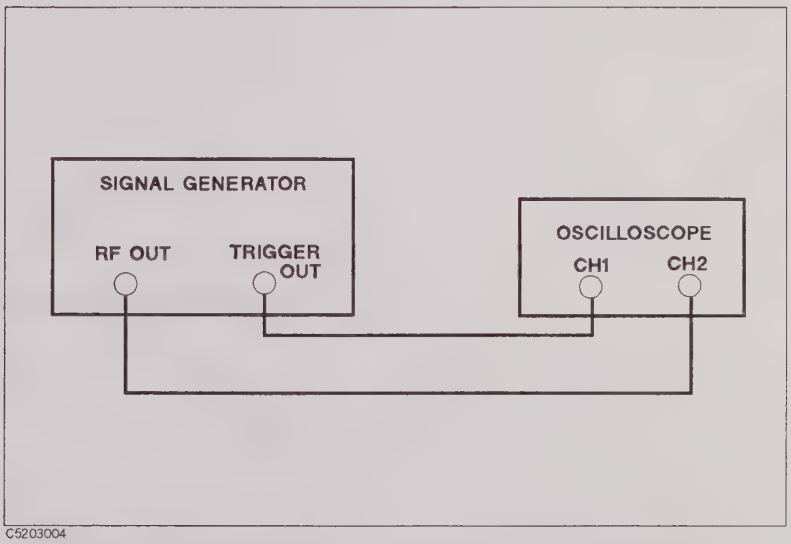


Figure 3-3. Time Domain Measurement Configuration

2. Adjust the oscilloscope to display the two signals.

3. Using the oscilloscope, check the following parameters:
   - For the target signal:
     - Signal width (τ)
     - Signal delay (SD)
   - For the trigger signal:
     - Pulse width (if you use the level trigger mode)

The signal delay (SD) is the delay inherent in the signal (that is, SD is the length of time after the trigger, but before the signal of interest occurred and becomes stable).

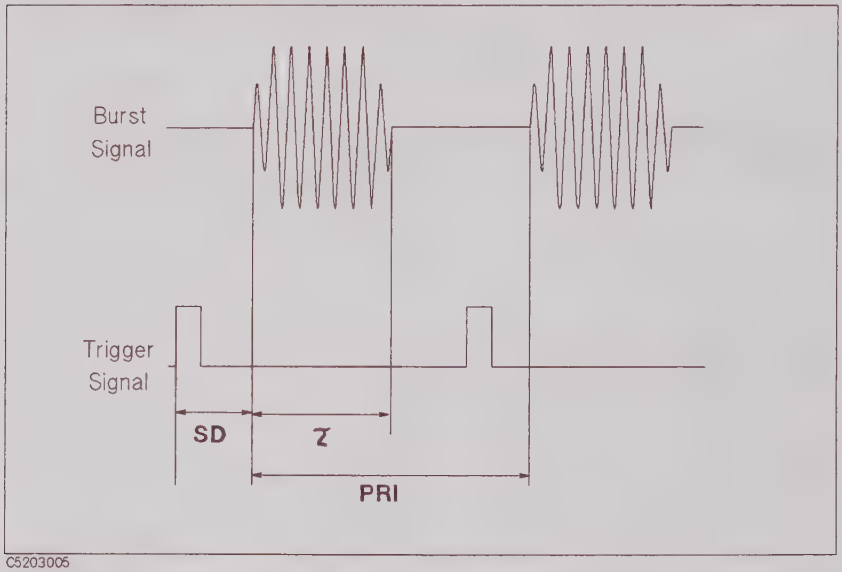


Figure 3-4. Target and Trigger Signal Timing on the Oscilloscope

4. Calculate the set up time (SUT) using, SUT = $\tau/2$.
5. Determine the gate parameters using the following equations:
   - Gate delay = SUT + SD
   - Gate length = $\tau/4$

Figure 3-5 shows the scheme of these parameters.

Open the "gate" during the time the signal is in a stable condition. The time from the start time of a signal and the open time of a gate is the "set up time" (SUT). Generally, SUT is set to half the pulse width. This is done so that you can allow the maximum time for the signal and RBW filter of the analyzer to become stable. You must also consider the end of the gate. Shut the gate before the last quarter of the pulse width to maintain a stable condition during the time the gate is open.

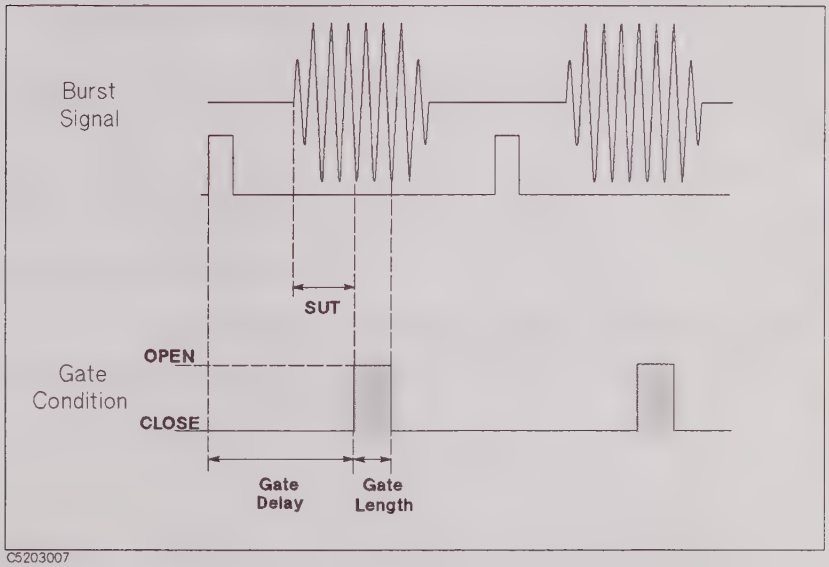


Figure 3-5. Gate Parameters

Step 2: Gate Trigger Source Connection

1. Connect the RF signal source to the S input of the analyzer.
2. Connect the trigger output from the signal source to the EXT TRIGGER connector on the rear panel of the analyzer.

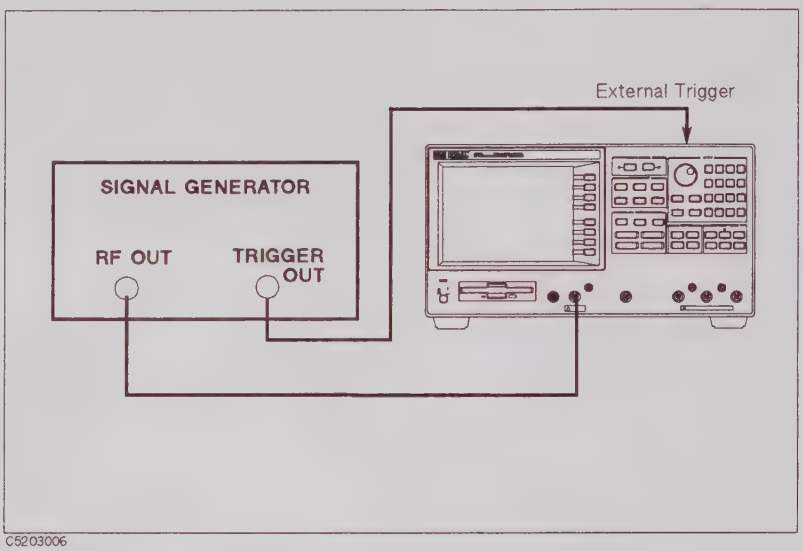


Figure 3-6. Time Gated Measurement Configuration

Step 3: Setting Center and Span Frequency

- Set up the center and span frequency of the analyzer to display the target signal.

Step 4: Adjusting Gate Trigger

1. Press (Trigger) CONTINUOUS to activate a gate trigger.
2. Press TRIGGER: [FREE RUN] .
3. Press GATE [LEVEL] .
4. Select the gate control mode. Select LEVEL or EDGE by toggling GATE CTL: LEVEL and EDGE to the required mode.
5. If you selected the LEVEL trigger mode, set the trigger polarity for starting the gate.
6. Press GATE DELAY .
7. Set a gate delay time.
8. If you select the EDGE trigger mode, press GATE LENGTH . Then set the gate open length.

You can see the gate trigger condition by monitoring the GATE Output terminal using an oscilloscope. The GATE Output terminal is located on the analyzer's rear panel.

For detailed information about the EDGE and LEVEL gate control modes, see the *Function Reference*.

Step 5: Setting RBW, VBW, and Averaging

To Set the Resolution Bandwidth

1. Press (Bw/Avg).
2. Set the resolution bandwidth wider than $\frac{2}{SUT}$.

The RBW setting you can use is limited by the gate open position. You can adjust a longer gate delay for a narrower RBW in step 5. This is because the RBW filters need charge time until normal condition. Therefore, you need to consider the balanced point between SUT and RBW. Generally, the RBW filter's charge time is defined as 2/RBW. Therefore, the SUT must be longer than 2/RBW or the RBW must be wider than 2/SUT.

Note

If the RBW is set narrower than 3 kHz, the analyzer turns into the stepped FFT mode. In the stepped FFT mode, the gate length must be longer than one FFT sampling step time. You must set the gate length longer than the minimum gate length that is listed in Table 3-1.

Table 3-1.
Minimum Gate Length setting with RBW setting

RBW	Allowable Gate Length
1 Hz	≥5.1857 s
3 Hz	≥1.6595 s
10 Hz	≥0.51858 s
30 Hz	≥0.13457 s
100 Hz	≥0.051213 s
300 Hz	≥0.012813 s
1 kHz	≥0.0032125 s
3 kHz	≥0.0016125 s

To Set the VBW

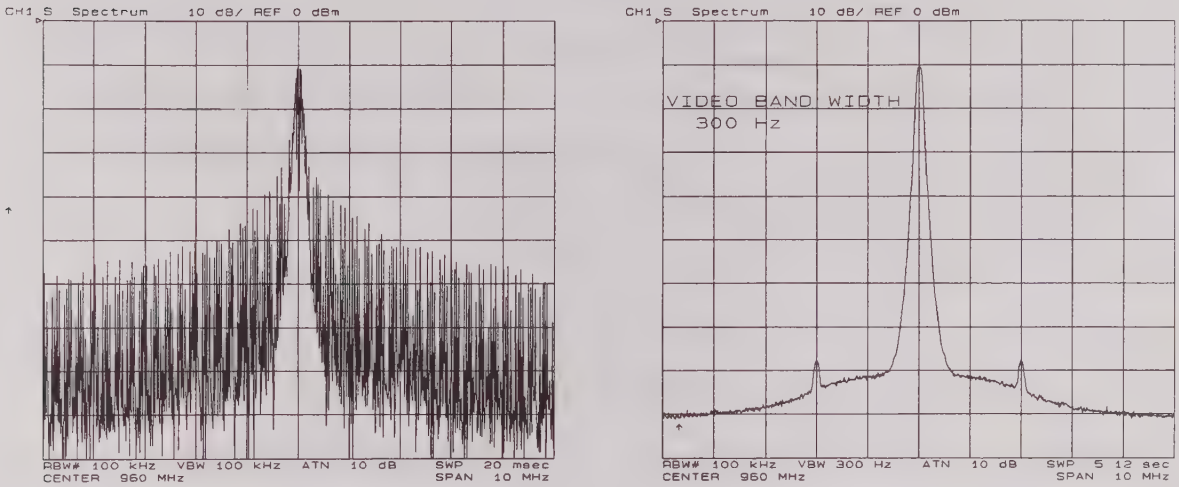
1. Press VIDEO BW.
2. Set the video bandwidth.

You can set any video bandwidth (VBW) without concern for the gate length setting. The analyzer implements the video filter using digital processing. The video filter of the analyzer requires no settling time for normal operation. Therefore, it is not affected by the gate length setting.

You can also use the averaging function to reduce the variation of the trace. The averaging function converges to the top of the variation. This is different from the VBW, which converges to the middle of the variation.

Step 6: Measuring

1. Adjust the span setting to fit the trace to your requirement.
2. Perform your measurement.


CH1 S Spectrum 10 dB/ REF 0 dBm
RBW# 100 kHz VBW 100 kHz ATN 10 dB SWP 20 msec
CENTER 960 MHz SPAN 10 MHz
CH1 S Spectrum 10 dB/ REF 0 dBm
VIDEO BAND WIDTH
300 Hz
RBW# 100 kHz VBW 300 Hz ATN 10 dB SWP 5 12 sec
CENTER 960 MHz SPAN 10 MHz

Before Time Gated

After Time Gated

Figure 3-7. Time Gated Spectrum Analysis

To Measure Zero Span

1. Determine the following parameters:
   - Sweep Time
   - Display Number of Points (NOP)
2. Press (Center). Then enter the frequency of the target signal.
3. Press (Span) ZERO SPAN to set the frequency span to 0 Hz.
4. Press (Sweep).
5. Select the sampling mode:
   - If (Sweep Time) / (NOP−1) ≥ 25 μs, then toggle to SAMPLING [NORM rept] . And Do both of step 6 and 7.
   - If (Sweep Time) / (NOP−1) < 25 μs, then toggle to SAMPLING [norm REPT] . And do either step 6 or 7.
6. Set the sweep time, press (Sweep) SWEEP TIME then enter the sweep time.
7. Set the number of points (NOP), by pressing (Sweep) NUMBER of POINTS and entering the NOP.

The allowable minimum sweep time is determined by the sampling mode and NOP. In the normal sampling mode, the minimum sweep time is 25 μs × NOP.

In the repetitive sampling mode, the sweep time is determined by 0.5 μs × NOP. This is because that the time resolution is fixed at 0.5 μs in the repetitive sampling mode.

Notes

You can set the RBW greater than 10 kHz. If you enter less than 10 kHz for the RBW, it is set to 10 kHz.

You must set the trigger source either EXTERNAL or VIDEO to select the repetitive sampling mode.

The detection mode is automatically set to the sample detection mode.

To Stabilize the Trace Using the Video Trigger

1. Press (Trigger).
2. Press TRIGGER: [FREE RUN] .
3. Press VIDEO .
4. Adjust the video trigger level by using to trigger the sweep at appropriate trace level.

If the sweep time and the pulse repetition rate (PRI) are not synchronized, the trace does not appear in the same position on the grid on every sweep. To avoid this, change the video trigger setting as appropriate.

To Read a Time Transition Using the Marker

1. Press (Utility).
2. Toggle `MKR TIME on OFF` to `ON off`.
3. Move the marker by using the .
4. Read the transition time that is displayed on the upper right of the grid.

When in zero span measurement, the marker displays the same frequency on every point of trace. Using the marker time function, you can change the marker display to the time format instead of the frequency. The marker displays a time transition from the left end of the grid.

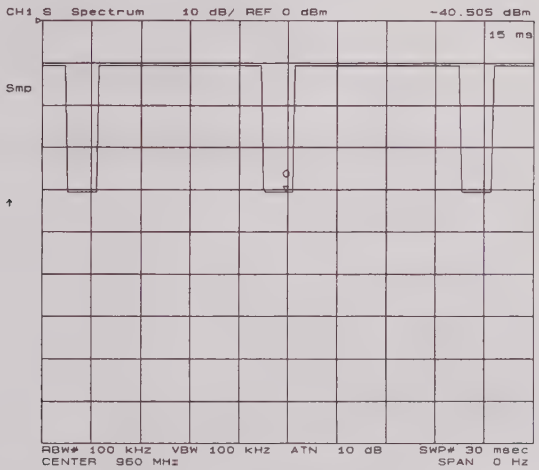


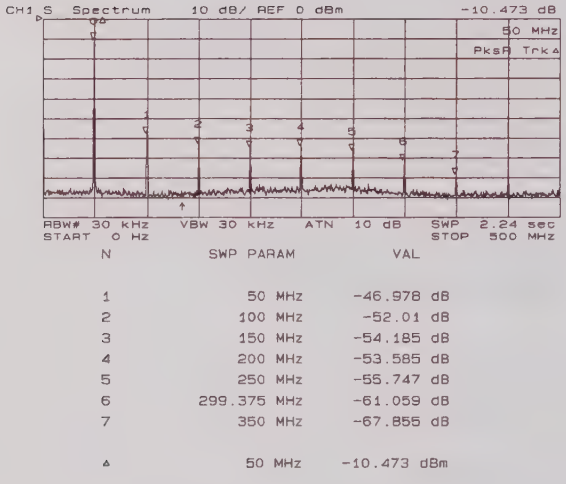
Figure 3-8. Marker Time

To Track Unstable Harmonics Using Search Track

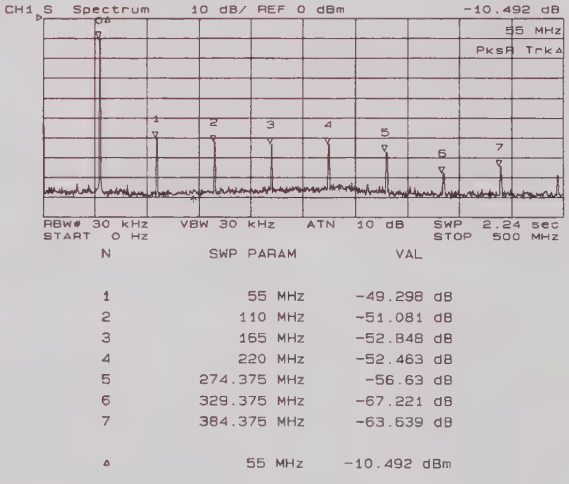
1. Set the frequency range to display the carrier and the harmonics.
2. Press (Search) SEARCH:PEAK to move the marker to the peak.
3. Press (Marker) ΔMODE MENU TRACKING ΔMKR to set up the marker as a reference Δmarker that can move with the carrier.
4. Toggle (Search) SEARCH TRK on OFF to ON off to enable the search function on every sweep.
5. Press MULTIPLE PEAKS SEARCH:PEAKS RIGHT to search for carrier and harmonics under the search track.
6. Press (Utility). Then toggle MKR LIST on OFF to ON off.

Even if the frequency of a carrier changes, the analyzer automatically tracks the carrier and the harmonics on the end of the sweep. Then the analyzer lists the difference between the carrier and the harmonics on the lower display.

If necessary, use the peak threshold to ignore the peaks other than the harmonics. See "To Ignore Small Peaks" in Chapter 2.


CH1 S Spectrum 10 dB/ REF 0 dBm -10.473 dB
50 MHz
PksR Trk
RBW# 30 kHz VBW 30 kHz ATN 10 dB SWP 2.24 sec
START 0 Hz STOP 500 MHz
N SWP PARAM VAL
1 50 MHz -46.978 dB
2 100 MHz -52.01 dB
3 150 MHz -54.185 dB
4 200 MHz -53.585 dB
5 250 MHz -55.747 dB
6 299.375 MHz -61.059 dB
7 350 MHz -67.855 dB
Δ 50 MHz -10.473 dBm

Carrier Frequency: 50 MHz


CH1 S Spectrum 10 dB/ REF 0 dBm -10.492 dB
55 MHz
PksR Trk
RBW# 30 kHz VBW 30 kHz ATN 10 dB SWP 2.24 sec
START 0 Hz STOP 500 MHz
N SWP PARAM VAL
1 55 MHz -49.298 dB
2 110 MHz -51.081 dB
3 165 MHz -52.848 dB
4 220 MHz -52.463 dB
5 274.375 MHz -56.63 dB
6 329.375 MHz -67.221 dB
7 384.375 MHz -63.639 dB
Δ 55 MHz -10.492 dBm

55 MHz

Figure 3-9. Tracking Unstable Harmonics Using Search Track

To Track and Zoom a Signal

Step 1: Setting the Wide Frequency Range

1. Set both channels to the spectrum analyzer mode.
2. Press (Display). Then toggle DUAL CHAN on OFF to ON off .
3. Select either channel to track the signal in wide span. Then set a frequency range that can display the signal as you change the frequency.
4. Press (Marker→).
5. Toggle CROSS CHAN on OFF to ON off
6. Press (Search) PEAK .
7. Toggle SIGNAL TRK on OFF to ON off .

Step 2: Setting the Narrow Frequency Range for the Other Channel

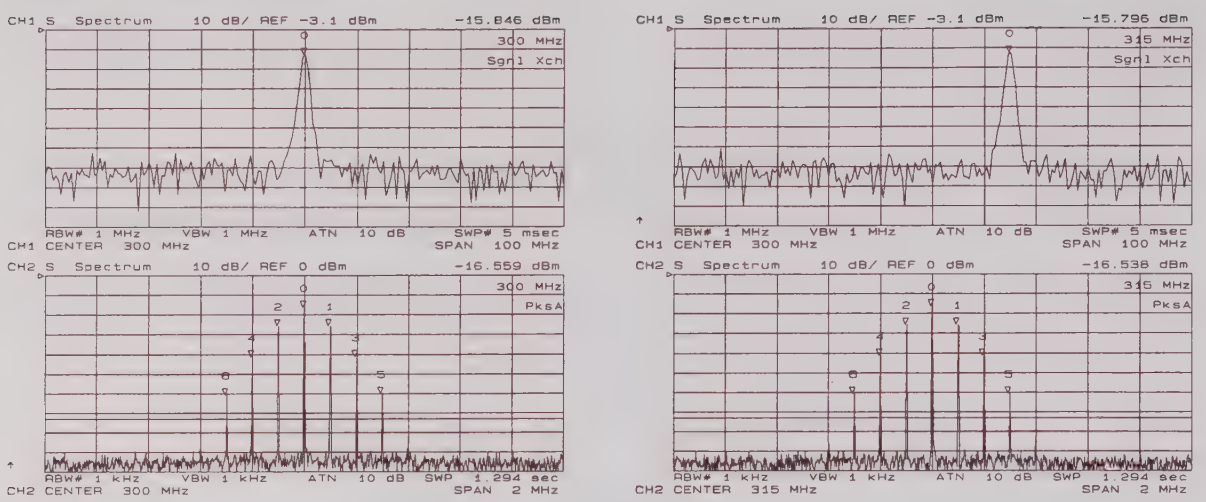
1. Select the other channel to display the zoomed signal in a narrow span.
2. Press (Span).
3. Enter the frequency span to display the detail of the target signal. Note that the span of the zoomed channel must be wider than the frequency resolution × 2 of the channel that is set in step 1.
4. Press (Search). Then toggle SEARCH TRK on OFF to ON off .
5. Use PEAK (or the marker search functions) to analyze the target signal.

The analyzer displays a wide view on the wide span channel and a detailed view on the zoomed channel. When the frequency of the signal is changed, the wide span channel tracks the signal and the center frequency of the zoomed channel automatically changes to display the target signal.

When the marker list is turned on, wide span channel disappears from the display. However, the wide span channel keeps tracking the signal in the background and displays the results on the zoomed channel.

For more information about frequency resolution, see "To Read a Value Using the Marker" in Chapter 2.

To Track and Zoom a Signal


CH1 S Spectrum 10 dB/ REF -3.1 dBm -15.846 dBm
300 MHz
Sgnl Xch
RBW# 1 MHz VBW 1 MHz ATN 10 dB SWP# 5 msec
CH1 CENTER 300 MHz SPAN 100 MHz
CH2 S Spectrum 10 dB/ REF 0 dBm -16.559 dBm
300 MHz
PksA
RBW# 1 kHz VBW 1 kHz ATN 10 dB SWP 1.294 sec
CH2 CENTER 300 MHz SPAN 2 MHz
CH1 S Spectrum 10 dB/ REF -3.1 dBm -15.796 dBm
315 MHz
Sgnl Xch
RBW# 1 MHz VBW 1 MHz ATN 10 dB SWP# 5 msec
CH1 CENTER 300 MHz SPAN 100 MHz
CH2 S Spectrum 10 dB/ REF 0 dBm -16.538 dBm
315 MHz
PksA
RBW# 1 kHz VBW 1 kHz ATN 10 dB SWP 1.294 sec
CH2 CENTER 315 MHz SPAN 2 MHz

300 MHz Carrier

315 MHz Carrier

Figure 3-10. Tracking and Zooming a Signal

Note

If the span of the zoomed channel is wider than the RBW of the wide channel, you can reduce the sweep time of the wide span channel. If the sweep time is reduced, the analyzer can track the faster movement of the target signal.

1. Press (Ch 1) or (Ch 2) to activate the wide span channel that has the active signal track function.
2. Press (Bw/Avg). Then set the RBW to the maximum setting that is narrower than the span of the zoomed channel.
3. Press (Sweep). Then press SWEEP TIME .
4. Press (0) (X1).

4

Recommended Network Measurement Task Sequence

This chapter describes a typical task sequence for any measurement using the network analyzer mode.

If you are using the analyzer for the first time, see the *User's Guide* first. The *User's Guide* provides the information needed to install and set up the analyzer, and a quick start guide to introduce you to the analyzer.

The measurement tasks described in this chapter are as follows:

- Step 1: Preparing for a measurement
- Step 2: Setting the sweep
- Step 3: Selecting the measurement format
- Step 4: Setting the sweep parameter
- Step 5: Setting the vertical settings
- Step 6: Tuning the settings
- Step 7: Performing calibration
- Step 8: Reading the measured result

Generally, you can make a measurement by performing these steps. If you want to perform a more complex network measurement, chapter 5 provides additional measurement techniques.

Step 1: Preparing for a Measurement

This step provides the procedures needed to prepare for a network measurement. You must perform the following tasks before you select measurement parameters (such as frequency range):

- To connect the test device
- To preset the analyzer
- To select the active channel
- To select the network analyzer mode

To Connect the Test Device

You must setup the test set before performing the network measurement. See appendix A of the *User's Guide* for the set up information of the test sets.

- Connect the device under test (DUT) as shown in Figure 4-1 or Figure 4-2.

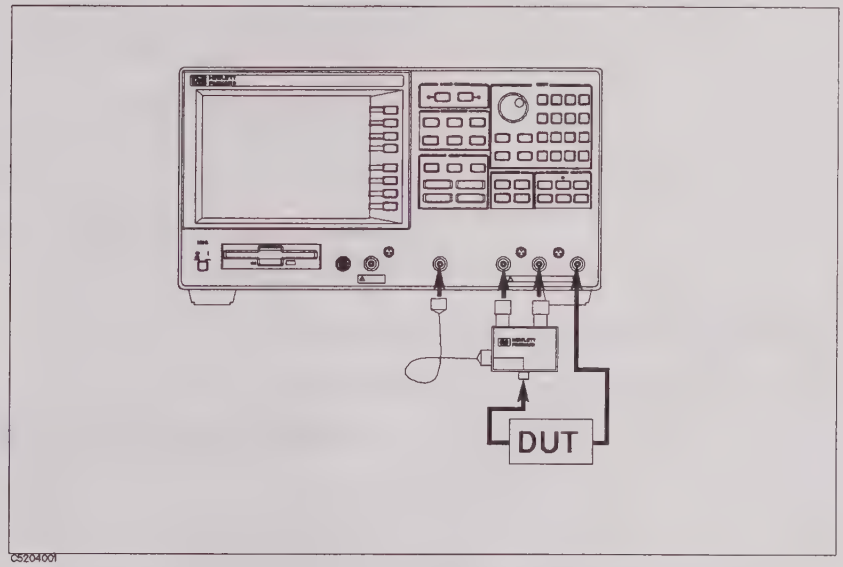


Figure 4-1. Using the Transmission/Reflection Test Set

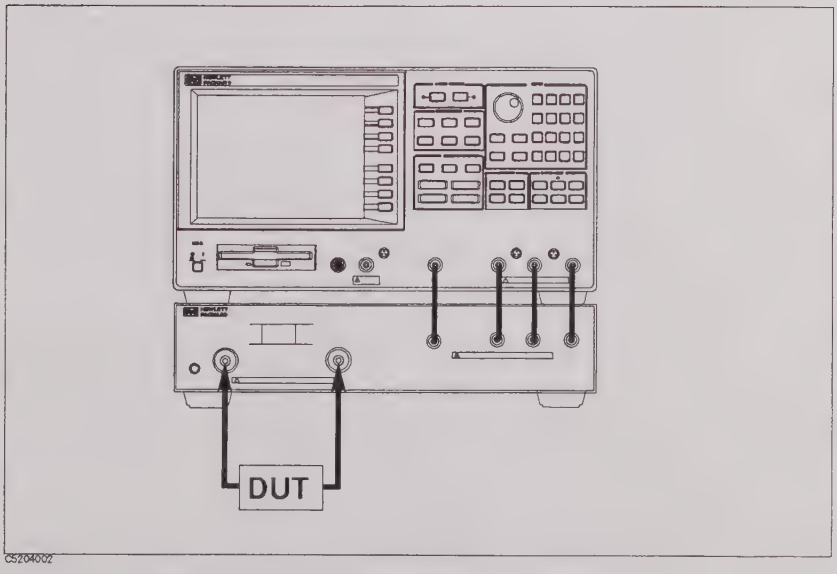


Figure 4-2. Using the S-Parameter Test Set

To Preset the Analyzer

- In the INSTRUMENT STATE block, press the green (Preset) key to set the analyzer to the preset state.

For additional information about the preset state, see the *Function Reference*.

To Select the Active Channel

- In the ACTIVE CHANNEL block, press (Ch 1) (channel 1) or (Ch 2) (channel 2) to select the active channel.

The analyzer has two independent channels. Each channel can have a different setting that includes whether the mode of operation is network analyzer or spectrum analyzer. Select the active channel before you set up any other settings.

Using this feature, you can change immediately to either of different two settings by pressing a single key.

To Select the Network Analyzer Mode

1. Press (Meas).
2. Press ANALYZER TYPE NETWORK ANALYZER.

When you change the analyzer type, the analyzer is set to the preset state. So, when you want to change the analyzer type, you must select it before you set up the other settings or just after you select the active channel.

Step 2: Setting the Sweep

This step selects the trigger source and the sweep condition.

- To select the trigger mode
  - To use the external trigger
  - To trigger on each display point
- To select the sweep condition
- To select the sweep type
  - To use the power sweep

To Select the Trigger Mode

1. Press (Trigger).
2. Press TRIGGER:[FREE RUN] .
3. Select the trigger mode:

To Select a Trigger to	Press
Free run	FREE RUN
External trigger source	EXTERNAL [1]
Manual	MANUAL

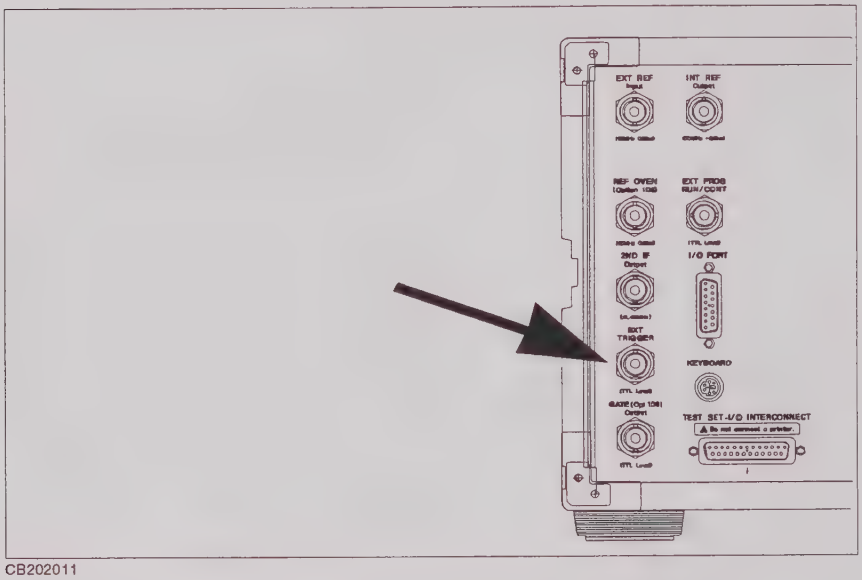
1 See the "To Use the External Trigger" procedure.

VIDEO and GATE (option 1D6 only) are only used for the spectrum measurements.

To Use the External Trigger

1. Connect the trigger source to the EXT TRIGGER connector on the rear panel of the analyzer.
2. Press (Trigger).
3. Press `TRIGGER:[FREE RUN]` .
4. Press `EXTERNAL` .
5. Input a trigger signal to the analyzer.

The external trigger signal level must be TTL Level.



CB202011

Figure 4-3. Location of EXT TRIGGER Connector

To Set the Trigger Signal Polarity.

1. Press (Trigger).
2. Press `TRIGGER:[FREE RUN]` .
3. Toggle `TRIG PLRTY POS neg` to `pos NEG` to turn the trigger polarity to the negative logic.

To Trigger on Each Display Point

1. Press (Trigger).
2. Press TRIGGER: [FREE RUN].
3. Select a trigger source:

Trigger source	Do
Manual	Press MANUAL.
External	Press EXTERNAL.

4. Toggle TRIG EVENT [ON SWEEP] to [ON POINT].
5. Apply a trigger event by pressing MANUAL (for MANUAL) or entering the external trigger signal (for EXTERNAL).

The sweep indicator ("↑") is moved to each point by the trigger event. You can select this mode only for MANUAL, EXTERNAL, or the bus trigger mode. For more information about the bus trigger mode, see the *HP-IB Command Reference.*

To Select the Sweep Condition

1. Press (Trigger).
2. Choose one of the following:

To Sweep	Do
Continuously	Press CONTINUOUS.
Single Time	Press SINGLE.
Specified Times	Press NUMBER of GROUPS. Then enter the number of times to sweep.

To Select the Sweep Type

1. Press (Sweep) SWEEP TYPE MENU.
2. Choose one of the following:

Sweep type	Do
Linear Frequency	Press LIN FREQ.
Log Frequency	Press LOG FREQ.
List Frequency	See "To Make a List Sweep" in Chapter 6.
Power Sweep	See the "To Use the Power Sweep" procedure.

To Use the Power Sweep

1. Press (Source) CW FREQ. Then enter the CW frequency.
2. Press (Sweep).
3. Press SWEEP TYPE MENU.
4. Press POWER SWEEP.
5. Enter the start and stop power.

For example, to sweep from −20 dBm to 10 dBm, press (Start) (2) (0) (−) (×1), (Stop) (1) (0) (×1).

You can set the sweep power with 0.1 dB resolution.

Step 3: Selecting the Measurement Format

This step provides following procedures for selecting measurement format:

- To select the input port
- To select the measurement format
- To display trace in a smith chart
- To use the impedance conversion function

To Select the Input Port

With the T/R Test Set

- Press (Meas).

To measure	Type	Press
Reflection	Ratio	A/R
Transmission	Ratio	B/R
Reflection	Absolute	A
Transmission	Absolute	B
Source	Absolute	R

With the S-Parameter Test Set

1. Set up the S-parameter test set. See Appendix A of the *User's Guide*.
2. Press (Meas).

To measure	Direction	Press
Reflection	Forward	Refl:FWD S11 [A/R]
Transmission	Forward	Trans:FWD S21 [B/R]
Transmission	Reverse	Trans:REV S12 [B/R]
Reflection	Reverse	Refl:REV S22 [A/R]

To Select the Measurement Format

1. Press (Format).
2. Select a measurement format from the following:

To Select	Press
LOG Magnitude	LOG MAG
Phase	PHASE
Group Delay	DELAY [1]
Smith Chart	SMITH CHART [2]
Polar Chart	POLAR CHART
Liner Magnitude	LIN MAG
Standing Wave Ratio (SWR)	SWR
Real Part Only	MORE FORMAT: REAL
Imaginary Part Only	MORE IMAGINARY
Expanded Phase	MORE EXPANDED PHASE
Admittance Chart (Inv. Smith Chart)	MORE ADMITTANCE CHART

1 See "To Display the Group Delay" in Chapter 5.

2 See the "To Display Trace As a Smith Chart" procedure.

If you selected an absolute measurement by selecting R, A or B under the (Meas) key, only the following formats can be selected:

To Select	Press
LOG Magnitude	LOG MAG
Liner Magnitude	LIN MAG
Standing Wave Ratio (SWR)	SWR

For more information about the measurement format, refer to chapter 5 of the *Function Reference* manual.

To Display Trace As a Smith Chart

1. Press (Format).
2. Press SMITH CHART to display the smith chart.
3. Use the marker to read a measured value, by pressing (Marker) and rotating .

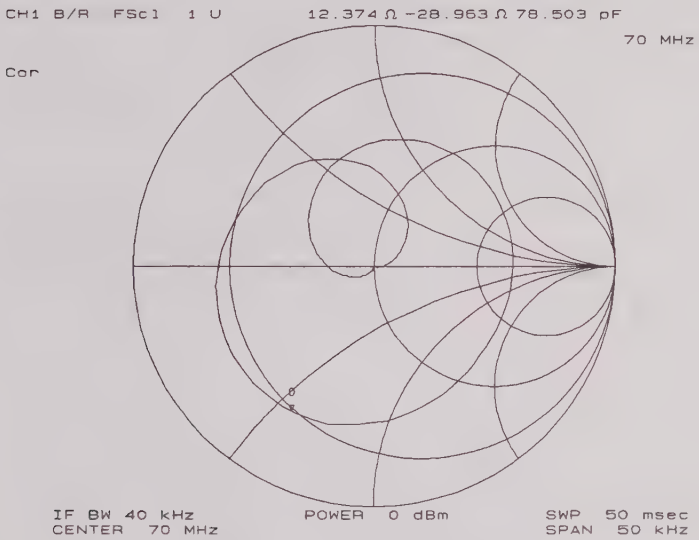


Figure 4-4. Smith Chart

To change the marker readout format, use the following procedure:

To Change Marker Readout Format

1. Press (Utility) SMTH/POLAR MENU.
2. Select display format using the following keys:

Format	Press
Real and Imaginary	CHART FMT: REAL IMAG
Linear Magnitude and Phase	LIN MAG PHASE
Log Magnitude and Phase	LOG MAG PHASE
Impedance	R+jX
Admittance	G+jB
SWR and Phase	SWR PHASE

To Use Impedance Conversion Function

1. Press (Meas).
2. Press CONVERSION [OFF] .
3. Select one of the formats listed below:

Convert to	Selected Port	Press
Impedance	A/R, S11, or S12	Z:Refl
	B/R, S21, or S22	Z:Trans
Admittance	A/R, S11, or S12	Y:Refl
	B/R, S21, or S22	Y:Trans

The marker readout value is a linear impedance or admittance value even if the LOG MAG format is selected.

For additional information about the impedance conversion function, see the *Function Reference*.

Step 4: Setting the Sweep Parameter

To Set the Sweep Parameter Using [Start] and [Stop]

1. Press [Start] to activate the start frequency function.
2. Change the start frequency setting using the following keys:

To	Use
Set directly	[0] ... [9] and units terminator keys
Change continuously	
Change with 1-2-5 steps	

3. Press [Stop].
4. Enter the stop frequency in a similar way.

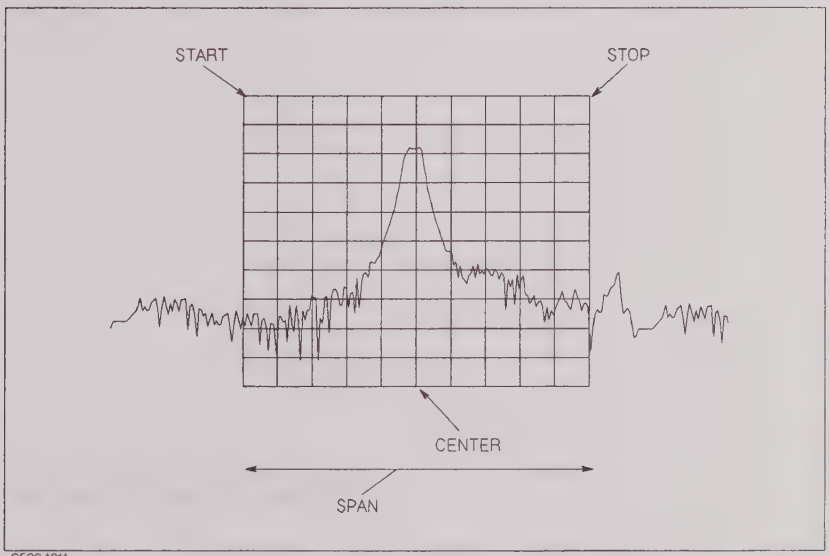


Figure 4-5. Sweep Parameter Setting

You can set the sweep parameter using [Center] and [Span] instead of [Start] and [Stop]. See "Step 4: Setting the Frequency Range" in Chapter 2.

Step 5: Setting the Vertical Settings

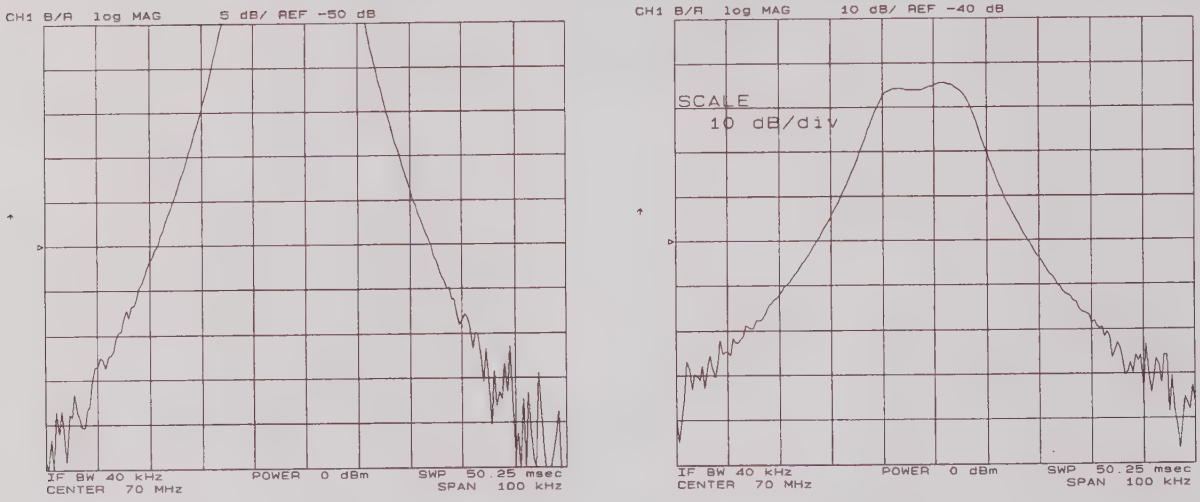
It is necessary to change a vertical setting if the trace is out of the grid or is too flat to see the required characteristics. This step provides the procedure needed to set the vertical scaling of the analyzer:

- To set the scale and reference automatically

To Set the Scale and Reference Automatically

1. Press (Scale Ref).
2. Press AUTO SCALE to fit the trace within the grid.

The scale and reference are automatically adjusted to obtain an optimum trace display.



Before Auto Scale

After Auto Scale

Figure 4-6. Autoscale Function

Notes

If you want to set the scale and reference value manually, the following functions are available:

- To change the scale per division setting, press SCALE/DIV .
- To change the reference position that is shown as "▶", use REFERENCE POSITION and ⇧ ⇩ keys.
- To change the reference value, use REFERENCE VALUE .

If you are displaying a data trace and a memory trace together, you need to consider whether you want to change the scale for one or both traces. You can change the traces as follows:

- If you want to change the scale setting for the data trace only, set SCALE FOR [DATA] and D&M SCALE[UNCOUPLE] under (Scale Ref) key.
- If you want to change the scale setting for the memory trace only, set SCALE FOR [MEMORY] and D&M SCALE [UNCOUPLE] .
- If you want to change the scale settings for the both traces, set D&M SCALE [COUPLE] .

Step 6: Tuning the Settings

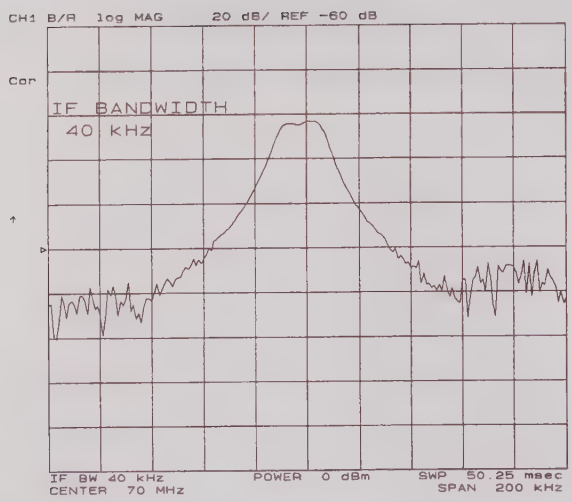
This step provides the following procedure:

- To increase the dynamic range

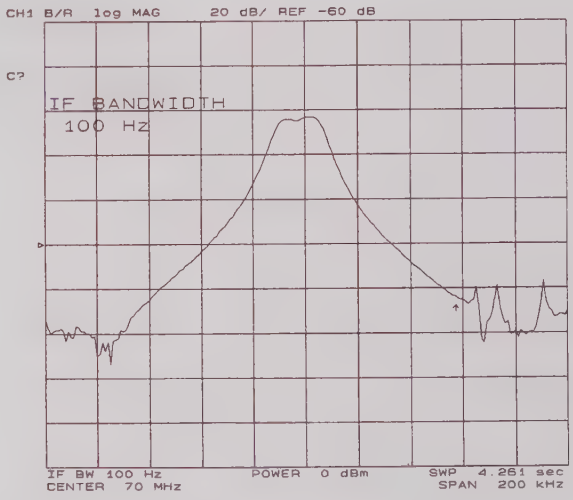
To Increase the Dynamic Range (Setting IF Bandwidth)

1. Press (Bw/Avg).
2. Press IF BW.
3. Press (↑) or (↓), or enter an IF bandwidth value directly from the numeric keypad.

Narrowing the IF bandwidth setting increases the dynamic range but it makes the sweep speed slower.



IF Bandwidth 40 kHz



IF Bandwidth 100 Hz

Figure 4-7. Setting IF Bandwidth (IFBW)

Notes

You can increase the dynamic range by using the following techniques:

- Apply the highest allowable power. The output power can be set by pressing (Source) POWER.
- Use the averaging. See "To Reduce Variation of the Measurement Trace Using Averaging".

Step 7: Performing Calibration

This step provide procedures for performing calibration. The calibration cancels the errors and improves the measurement accuracy. The analyzer has six different methods of calibration. You can select the method that fits your measurement requirement by reading "To Select an Appropriate Calibration Method" procedure. This step also contains a procedure to customize a calibration kit.

- To select an appropriate calibration method
- To perform a response calibration
- To perform a response & isolation calibration
- To perform an S11 1-port calibration
- To perform an S22 1-port calibration
- To perform a full 2-port calibration
- To perform a 1-path 2-port calibration
- To select the calibration kit
- To customize the user defined calibration kit

To Select an Appropriate Calibration Method

The analyzer has six calibration methods. You can choose the appropriate calibration method to fit your measurement by using Table 4-1.

Table 4-1. Calibration Method Selection Table

Measurement Type	Calibration Method	Complexity	See
Transmission or reflection measurement when the highest accuracy is not required.	Response	simple	"To Perform a Response Calibration"
Transmission of high insertion loss devices or reflection of high return loss devices. Not as accurate as 1-port or 2-port calibration.	Response & isolation	simple	"To Perform a Respornse & Isolation Calibration"
Reflection of any one-port device or well terminated two-port device.	S_{11} 1-port	slightly complex	"To Perform an S11 1-Port Calibration"
Reflection of any one-port device or well terminated two-port device.	S_{22} 1-port	slightly complex	"To Perform an S22 1-Port Calibration"
Transmission or reflection of highest accuracy for two-port devices. S-parameter Test Set is required.	Full 2-port	complex	"To Make Full 2-Port Calibration"
Transmission or reflection of highest accuracy for two-port devices. (Reverse test device between forward and reverse measurements.)	One-path 2-port	complex	"To Perform a 1-Path 2-Port Calibration"

To Perform a Response Calibration

1. Press (Cal) CALIBRATE MENU RESPONSE to display the response calibration menu.
2. Connect one of following standards. Then press the corresponding key.

Measurement Type	Connect Standard	Press
Transmission Measurement	THRU	THRU
Reflection Measurement	OPEN	OPEN
	SHORT	SHORT

3. Press DONE: RESPONSE .

To Perform a Response & Isolation Calibration

1. Press (Cal) CALIBRATE MENU RESPONSE & ISOL'N to display the response and isolation calibration menu.
2. Press RESPONSE .
3. See 2 of the "To Perform a Response Calibration" procedure.
4. Press DONE: RESPONSE .
5. Connect isolation standard (LOAD).
6. Press ISOL'N STD .
7. Press DONE RESP ISOL'N CAL .

To Perform an S11 1-Port Calibration

Step 1: Opening the S-11 1-Port Calibration Menu

1. Press (Cal).
2. Select the proper calibration kit. If the connector type or calibration kit name shown in the CAL KIT softkey label is not the same as the calibration kit to be used, see the "To Select the Calibration Kit" procedure.
3. Press CALIBRATE MENU S11 1-PORT.

Step 2: Measuring the OPEN

1. Connect OPEN standard to port 1.
2. Press (S11):OPEN (for the 7 mm or 3.5 mm cal kit) or (S11):OPENS (for the type-N cal kit).

   When the 7 mm or 3.5 mm calibration kit is selected, the message "WAIT - MEASURING CAL STANDARD" is displayed while the OPEN data is measured. The softkey label OPEN is then underlined. Skip to step 3.
3. If the type-N calibration kit is selected, do the following.
   a. Press OPEN [M] (for a male port connector) or press OPEN [F] (for a female port connector).

      The OPEN data is measured and the softkey label is then underlined.
   b. Press DONE:OPENS.

Step 3: Measuring the SHORT

1. Disconnect the OPEN. Then connect a SHORT standard to port 1.
2. Press SHORT (for the 7 mm or 3.5 mm calibration kit) or SHORTS (for the type-N calibration kit).

   When the 7 mm or 3.5 mm calibration kit is selected, the SHORT data is measured and the softkey label is underlined. Skip to step 4.
3. If the type-N calibration kit is selected, do the following.
   a. Press SHORT [M] (for a male port connector) or press SHORT [F] (for a female port connector).

      The SHORT data is measured and the softkey label is then underlined.
   b. Press DONE:SHORTS.

Step 4: Measuring the LOAD

1. Disconnect the SHORT, and connect an impedance-matched LOAD (usually 50 or 75 Ω) at port 1.

2. Press LOAD. Then wait the LOAD is measured and the LOAD softkey is underlined.

Step 5: Completing the Calibration

1. Press DONE 1-PORT CAL to complete the calibration.

The error coefficients are computed, and the correction menu is returned to the screen with CORRECTION ON. A corrected S11 trace is displayed, and "Cor" appears at the left side of the screen.

If you press DONE without measuring all the required standards, the message "CAUTION: ADDITIONAL STANDARDS NEEDED" is displayed.

To Perform an S22 1-Port Calibration

This calibration is similar to the S11 1-port calibration except that S22 is selected automatically. It is used only with an S-parameter test set.

For S-parameter measurements in the reverse direction with a transmission/reflection test kit, use the S11 1-port or 1-path 2-port calibration and reverse the DUT between measurement sweeps.

To Make Full 2-Port Calibration

Step 1: Calling the Full 2-Port Calibration Menu

1. Press (Cal).
2. Select the proper calibration kit. If the connector type or calibration kit name shown in the CAL KIT softkey label is not the same as the calibration kit to be used, see the "To Select the Calibration Kit" procedure.
3. Press CALIBRATE MENU FULL 2-PORT REFLECT'N.

Step 2: Measuring the Reflection

1. Connect a shielded OPEN to port 1.
2. Press (S11): OPEN (for the 7 mm or 3.5 mm calibration kit) or (S11): OPENS (for the type-N calibration kit).

   When the 7 mm or 3.5 mm calibration kit is selected in step 1, the OPEN data is measured and the softkey label OPEN is underlined.
3. If the type-N calibration kit is selected, do the following.
   a. Press OPEN [M] (for a male port connector) or press OPEN [F] (for a female port connector).

      The OPEN data is measured. The softkey label is then underlined.
   b. Press DONE:OPENS.
4. Disconnect the OPEN and connect the SHORT to port 1.
5. Press (S11): SHORT (for the 7 mm or 3.5 mm calibration kit) or (S11): SHORTS (for the type-N calibration kit).

   When the 7 mm or 3.5 mm calibration kit is selected, the SHORT data is measured and the softkey label SHORT is underlined.
6. If the type-N calibration kit is selected, do the following.
   a. Press SHORT [M] (for a male port connector) or press SHORT [F] (for a female port connector).

      The SHORT data is measured and the softkey label is then underlined.
   b. Press DONE:SHORTS
7. Disconnect the SHORT and connect an impedance-matched LOAD (usually 50 or 75 Ω) at port 1.
8. Press (S11): LOAD. Then confirm the LOAD softkey label is underlined.
9. Repeat the OPEN-SHORT-LOAD measurements described above, connecting the devices in turn to port 2 and using the (S22) softkeys.

10. Press REFLECT'N DONE.

The reflection calibration coefficients are computed and stored. The two-port calibration menu is displayed (with the REFLECT'N softkey underlined).

Step 3: Measuring the Transmission

1. Press TRANSMISSION.
2. Connect a THRU connection between port 1 and port 2 at the points where the test device is connected.
3. When the trace settles, press FWD. TRANS. THRU. Then wait S21 frequency response is measured and the softkey label is underlined.
4. Press FWD. MATCH THRU. Then wait the S11 load match is measured and the softkey label is underlined.
5. Press REV. TRANS. THRU. Then wait the S12 frequency response is measured and the softkey label is underlined.
6. Press REV. MATCH THRU. Then wait the S22 load match is measured and the softkey label is underlined.
7. Press TRANS. DONE.

The transmission coefficients are computed and stored. The two-port calibration menu is displayed (with the TRANSMISSION softkey underlined).

Step 4: Measuring the Isolation

1. If correction for isolation is not required, press ISOLATION OMIT ISOLATION ISOLATION DONE. Then skip to step 5.
2. If correction for isolation is required, connect impedance-matched LOADs to port 1 and port 2.
3. Press FWD ISOL'N ISOL'N STD. Then wait the S21 isolation is measured and the softkey label is underlined.
4. Press REV ISOL'N ISOL'N STD. Then wait the S12 isolation is measured and the softkey label is underlined.
5. Press ISOLATION DONE.

The isolation error coefficients are stored. The two-port calibration menu is displayed (with the ISOLATION softkey underlined).

Step 5: Completing the Calibration

1. Press DONE: 2-PORT CAL to complete the calibration.

The error coefficients are computed and stored. The correction menu is displayed (with CORRECTION ON). A corrected trace is displayed. The notation "C2" at the left of the screen indicates that two-port error correction is ON.

Now the test device can be connected and measured. Save the calibration data on the built-in disk drive.

To Perform a 1-Path 2-Port Calibration

Step 1: Calling the 1-Path 2-Port Calibration Menu

1. Press Cal.
2. Select the proper calibration kit. If the connector type or calibration kit name shown in the CAL KIT softkey label is not the same as the calibration kit to be used, see the "To Select the Calibration Kit" procedure.
3. Press CALIBRATE MENU ONE-PATH 2-PORT REFLECT'N.

Step 2: Measuring the Reflection

1. Connect a shielded OPEN to the test port.
2. Press (S11): OPEN (for the 7 mm calibration kit) or (S11): OPENS (for the type-N calibration kit).

   The OPEN data is measured, and the softkey label OPEN is underlined.
3. If the type-N calibration kit is selected, do the following.
   a. Press OPEN [M] (for a male port connector) or press OPEN [F] (for a female port connector).

      The OPEN data is measured and the softkey label is then underlined.
   b. Press DONE:OPENS.
4. Disconnect the OPEN and connect a SHORT to the test port.
5. Press SHORT (for the 7 mm or 3.5 mm calibration kit) or SHORTS (for the type-N calibration kit).

   When the 7 mm or 3.5 mm calibration kit is selected, the SHORT data is measured and the softkey label SHORT is underlined.
6. If the type-N calibration kit is selected, do the following.
   a. Press SHORT [M] (for a male port connector) or press SHORT [F] (for a female port connector).

      The SHORT data is measured and the softkey label is then underlined.
   b. Press DONE:SHORTS.
7. Disconnect the SHORT and connect an impedance-matched LOAD (50 or 75 Ω) to the test port.
8. Press LOAD. Then wait the LOAD is measured and the softkey label LOAD is underlined.
9. Press REFLECT'N DONE.

The reflection calibration coefficients are computed and stored. The two-port calibration menu is displayed (with the REFLECT'N softkey underlined).

Step 3: Measuring the Transmission

1. Connect a THRU between the test port and the return cable to the analyzer (connect to the points at which the test device is connected).
2. Press TRANSMISSION.
3. Press FWD. TRANS. THRU. Then wait the S21 frequency response is measured and the softkey label is underlined.
4. Press FWD. MATCH THRU. Then wait the S11 load match is measured and the softkey label is underlined.
5. Press TRANS. DONE.

The transmission coefficients are computed and stored. The two-port calibration menu is displayed (with the TRANSMISSION softkey underlined).

Step 4: Measuring the Isolation

1. If correction for isolation is not required, press ISOLATION OMIT ISOLATION ISOLATION DONE. Skip to step 5.
2. If correction for isolation is required, connect impedance-matched LOADs to the test port and the return port.
3. Press FWD ISOL'N ISOL'N STD. Then wait the S21 isolation is measured and the softkey label is underlined.
4. Press ISOLATION DONE.

The isolation error coefficients are stored. The two-port calibration menu is displayed (with the ISOLATION softkey underlined).

Step 5: Completing the Calibration

1. Press DONE 2-PORT CAL to complete the calibration.

The error coefficients are computed and stored. The correction menu is displayed with CORRECTION ON. A corrected trace is displayed. The notation "C2" at the left of the screen indicates that 2-port error correction is ON.

Step 6: Performing the Measurement

1. Connect the test device in the reverse direction. Then press PRESS to CONTINUE.
2. Reconnect the test device in the forward direction. Then press PRESS to CONTINUE.

Now the error corrected trace is displayed. If you measure the other test device, press (Trigger) MEASUREMENT RESTART . Then perform the procedure of step 6.

Save the calibration data on a disk or RAM disk.

For additional information about calibration, see chapter 5 of the *Function Reference*.

To Select the Calibration Kit

1. Press (Cal).
2. Press CAL KIT [...].
3. Press one of the following keys:

Calibration Kit	Press
7 mm calibration kit	CAL KIT: 7mm
3.5 mm calibration kit	3.5mm
50 Ω N type	N 50Ω
75 Ω N type	N 75Ω
User defined calibration kit	USER KIT

To Customize the User Defined Calibration Kit

To Define the Standard Definition

Step 1: Preparation.

1. Prepare the "*Standard Definitions*" table of the standard kit you want to use.

Table 4-2 is an example of a standard definition table.

Table 4-2.
Example of the Standard Definitions (HP 85032B 50Ω Type-N Calibration Kit)

STANDARD		C0	C1	C2	C3	FIXED OR	OFFSET			FREQUENCY (GHz)		COAX or	STANDARD
).	TYPE	$\times 10^{-15}$F	$\times 10^{-27}$F	$\times 10^{-36}$F/Hz	$\times 10^{-45}$F/Hz	SLIDING	DELAY ps	LOSS MΩ/s	Z_0 Ω	MINIMUM	MAXIMUM	WAVEGUIDE	LABEL
	SHORT						0	700	50	0	999	COAX	SHORT(M)
	OPEN	108	55	130	0		0	700	50	0	999	COAX	OPEN(M)
	LOAD					FIXED	0	700	50	0	999	COAX	BROAD-BAND
	DELAY/THRU						0	700	50	0	999	COAX	THRU
	SHORT						17.544	700	50	0	999	COAX	SHORT(F)
	OPEN	62	17	28	0		17.544	700	50	0	999	COAX	OPEN(F)

Step 2: Activating the Define Standard Menu.

1. Press (Cal).
2. Press CAL KIT [...].
3. Press MODIFY [...].
4. Press DEFINE STANDARD.
5. Select standard number.

6. Select standard type.

If you did not select standard type as OPEN in step 2, skip to step 4.

Step 3: Entering a C Parameters.

1. Press C0. Then enter C0 ($\times 10^{-15}$F).
2. Press C1. Then enter C1 ($\times 10^{-27}$F/Hz).
3. Press C2. Then enter C2 ($\times 10^{-36}$F/Hz^2).

Step 4: Entering an OFFSET Parameters.

1. Press SPECIFY OFFSET.
   - Press OFFSET DELAY. Then enter DELAY.
   - Press OFFSET LOSS. Then enter LOSS.
   - Press OFFSET Z0. Then enter Z_0.
2. Press STD OFFSET DONE.

Step 5: Entering a Standard Class Label.

1. Press LABEL STD.
2. Enter a standard label up to 10 characters.
3. Press DONE.

Step 6: Completing the Definition of a Calibration Kit.

1. Press STD DONE (DEFINED).
2. Press KIT DONE (MODIFIED).

To Define a Class Assignment

Step 1: Preparing for the Class Assignment.

1. Prepare the standard class assignment table for your calibration kit.

Table 4-3.
Standard Class Assignment of the HP 85032B

	A	B	C	D	E	F	G	STANDARD CLASS LABEL
$S_{11}A$	2	8						OPENS
$S_{11}B$	1	7						SHORTS
$S_{11}C$	3							LOAD
$S_{22}A$	2	8						OPENS
$S_{22}B$	1	7						SHORTS
$S_{22}C$	3							LOAD
Forward Transmission	4							Fwd. Trans Thru
Reverse Transmission	4							Rev. Trans Thru
Forward Match	4							Fwd. Match Thru
Reverse Match	4							Rev. Match Thru
Response	1	7	2	8	4			RESPONSE
Response & Isolation	1	7	2	8	4			Response & Isol'n

Step 2: Specifying the Class.

1. Press SPECIFY CLASS .
2. Select standard class.

To Select	Press
$S_{11}A$	SPECIFY: S11A
$S_{11}B$	S11B
$S_{11}C$	S11C
$S_{22}A$	SPECIFY: S22A
$S_{22}B$	S22B
$S_{22}C$	S22C
Forward Transmission	MORE SPECIFY: FWD. TRANS.
Reverse Transmission	MORE REV.TRANS.
Forward Match	MORE FWD. MATCH
Reverse Match	MORE REV.MATCH
Response	MORE RESPONSE
Response & Isolation	MORE RESPONSE & ISOL'N

3. Enter the standard number from A to G.
4. Press CLASS DONE (SPEC'D) .

Step 3: Labeling the Standard Class Label.

1. Press LABEL CLASS to label the standard class.
2. Select the standard class.
   See 2 of Step 2.
3. Enter or modify the correspondent standard class label.
4. Press LABEL DONE .

To Label and Save Calibration Kit.

1. Press LABEL KIT .
2. Enter label.
3. Press DONE KIT DONE (MODIFIED) .
4. Press CAL KIT [...] SAVE USER KIT USER KIT .
5. Press RETURN .

After the user-defined calibration kit is defined, you can verify the definition using the copy function that lists standard parameters and class assignment.

To Verify Definition of User-Defined Calibration Kit.

1. Press (Cal) `CAL KIT [...]` `USER KIT` to specify the calibration kit as a user-defined kit.
2. Press (Copy) `MORE` `CAL KIT DEFINITION`.
   - To display the standard parameters defined, press `STANDARD DEFINITON`. Then press the softkey labeled standard number if you want to list the defined parameters.
   - To display the defined class assignment, press `CLASS ASSIGNMENT`.
3. To make a hardcopy, press `PRINT [STANDARD]`.
4. To return to the normal display, press `RESTORE DISPLAY`.

Step 8: Reading the Measured Result

If you can obtain the correct trace on the display, you can readout the trace gain and frequency by using the marker. The analyzer can search for specific points (like peaks or ripples) by using the marker search function. This step provides procedures for reading values using the marker and the marker search functions.

- To read a value using the marker
- To stabilize the trace
- To use the sub-markers
- To use the Δmarker
- To search for a point which has the target value
- To search for the peak-to-peak of ripples using the statistics function
- To define the peak for search

To Read a Value Using the Marker

1. Press (Marker).
2. Move the marker to the point you want to read using the .
3. Read the marker value displayed on the upper right of the display.

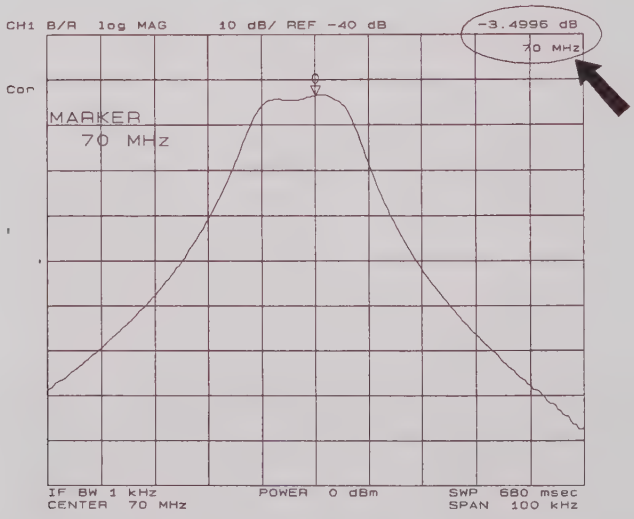


Figure 4-8. Marker Readout

To Stabilize the Trace

When the marker value changes frequently and it is difficult to read the value, you can use the following techniques to stabilize the trace:

- Stop the sweep.
- Use the averaging function.

To Stop the Sweep

1. Press (Trigger).
2. Press SWEEP: HOLD.

The sweep is stopped immediately (even if the sweep is in progress). If you want to restart the sweep, press CONTINUOUS.

To Reduce Variation of the Measurement Trace Using Averaging

1. Press (Bw/Avg).
2. Press AVERAGING FACTOR.
3. Enter the number of times to average. Then press (x1).
4. Toggle AVERAGING on OFF to ON off.

"Avg" appears on the left side of display when averaging is turned on. The averaging notation counts the averaging factor during averaging until it reaches the specified averaging factor. When averaging is completed, the counter halts and the trace continues updating with each sweep.

The averaging factor can be set from 0 to 999.

If you want to change the setting of any parameter when averaging, you can restart averaging from the 0 count.

To Restart the Averaging.

1. Press (Bw/Avg).
2. Press AVERAGING RESTART.

This resets the averaging counter to 0 and the counter starts incrementing with every sweep.

To Use the Sub-markers

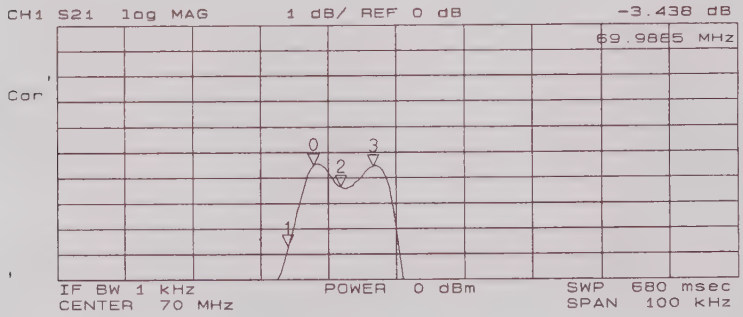
1. Press (Marker).
2. Move the marker to a point where you want to set a sub-marker.
3. Press SUB MKR.
4. Select from SUB MKR 1 to 7.
5. Press (Utility).
6. Toggle MKR LIST on OFF to ON off.

The sub-marker appears at the point of that the marker is displayed. Sub-markers are fixed horizontally and you cannot move them.

The sub-marker value can only be displayed by using the marker list.

To clear a sub-marker, press (Marker) CLEAR SUB MKR. Then press the sub-marker number that you want to erase from the display.

To clear all the markers, press (Marker) PRESET MKRS.



N	SWP PARAM	VAL
0	69.9885 MHz	-3.438 dB
1	69.9844 MHz	-6.4504 dB
2	69.9925 MHz	-4.4068 dB
3	69.99685 MHz	-3.5189 dB

Figure 4-9. Sub-markers

To Use the ΔMarker

1. Press (Marker).
2. Place the marker on the point you want use as a reference point using the .
3. Press ΔMODE MENU.
4. Press ΔMKR. The reference marker appears at the marker place.
5. Move the marker by using the following procedures:
   - Enter a difference frequency (or power) by using the numerical keys.
   - Turn the rotary knob until the marker moves to the point you want to read the value.
6. Read the gain and the frequency (or power) differences from the reference marker that are displayed on the upper right of the grid.

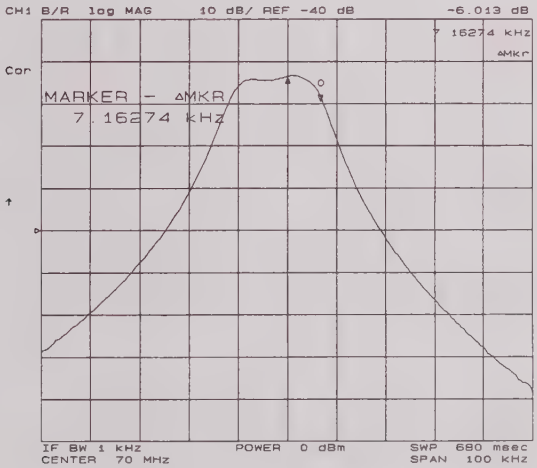


Figure 4-10. ΔMarker

To Search For a Point that has the Target Value

1. Press (Search).
2. Press TARGET .
3. Enter the target value using (0) . . . (9) and the unit terminator keys.

To search for a target on	Press
All of the display	TARGET
Left side of the marker	SEARCH LEFT
Right side of the marker	SEARCH RIGHT

When the Δmarker is active, the target value becomes the difference from the reference marker, not an absolute value. For example, you can search for the -3 dB cutoff point of a filter by mixing the Δmarker and the target search function.

To Search for the Peak-to-Peak of Ripples Using the Statistics Function

Step 1: To Specify the Search Range

1. Press (Marker). Then move the marker to the start point of the range.
2. Press `ΔMODE MENU` `ΔMKR` to place the reference marker on the start point of the range.
3. Move the marker to the end point of the range.
4. Press (Search) `SEARCH RANGE MENU`.
5. Toggle `PART SRCH on OFF` to `ON off`.
6. Press `MKRΔ→SEARCH RNG` to set the range defined by the reference marker and the marker as the search range.

Triangle-shaped indicator (△) at the bottom of the grid shows current search range.

Step 2: To Search For the Ripple

1. Press (Utility).
2. Toggle `STATISTICS on OFF` to `ON off`.

`STATISTICS` displays the mean value (`mean`), the standard deviation (`s.dev`), and the peak-to-peak value (`p-p`) of the ripple within the specified range of the active channel. This information is displayed on the upper right of the display (see Figure 4-11). If you did not specify the search range, the analyzer searches within the displayed area.

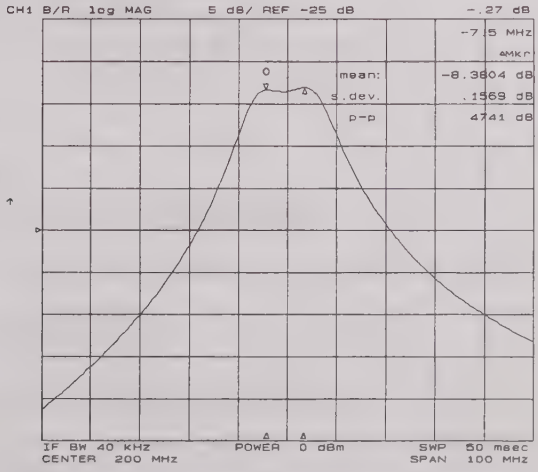


Figure 4-11. Ripple Parameters Readout

To Define the Peak for Search

You can define the target peak for the search function using the following techniques:

- Defining the peak slope to ignore the relatively broad peaks.
- Specifying the peak threshold to ignore the absolutely small peaks.

Defining the Peak Slope to Ignore the Relatively Broad Peaks

Entering Directly.

1. Press (Search) SEARCH:PEAK .
2. Press PEAK DEF MENU .
3. Press PEAK DEF:ΔX . Then enter a width of the peak.
4. Peak PEAK DEF:ΔY . Then enter a height of the peak.

Using the Marker.

1. Press (Marker). Then move the marker on the local maximum you want to search.
2. Press ΔMODE MENU ΔMKR
3. Press (Search) SEARCH:PEAK PEAK DEF MENU .
4. Move the marker to the foot of the peak.
5. Press MKR→PEAK DELTA .

This parameter defines the slope of the peak. The definition is made by defining ΔX and ΔY as shown in Figure 4-12. The search function searches only for peaks that are steeper than the specified slope. Use this function when the search function searches for a peak that has a gentle slope.

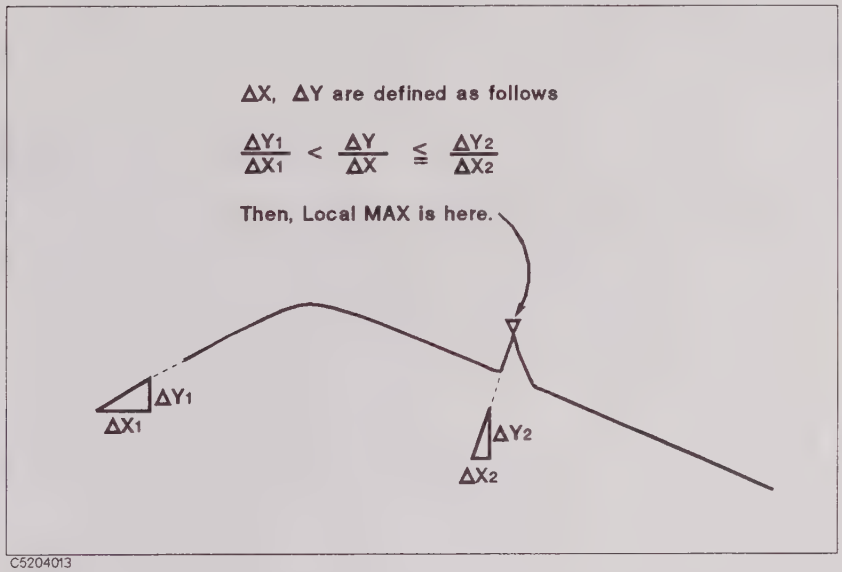


Figure 4-12. Peak Definition

Specifying the Peak Threshold to Ignore the Absolutely Small Peaks

Entering Directly.

1. Press (Search) SEARCH:PEAK PEAK DEF MENU.
2. Press THRESHOLD VALUE.
3. Enter a threshold value.
4. Toggle THRESHOLD on OFF to ON off.

The red threshold line is displayed. The all search function searches for only the upper side of the threshold line.

Using the Marker.

1. Press (Search).
2. Press SEARCH:PEAK PEAK DEF MENU.
3. Move the marker to the point you want to set as the threshold value.
4. Press MKR→THRESHOLD.
5. Toggle THRESHOLD on OFF to ON off.

For more information about a peak definition, see chapter 12 of the *Function Reference*.

5

Typical Network Measurements

This chapter provides the following typical measurement techniques using the network analyzer mode of operation:

- To measure the 3 dB bandwidth using the width function
- To monitor the spectrum of the network measurement input
- To measure the electrical length
- To measure the phase deviation
- To cancel an extension of a measurement cable

To Measure the 3 dB Bandwidth Using the Width Function

1. Press (Search).
2. Do either one of the following:

To Use	Do
Maximum point as a reference	Press MAX.
Nominal frequency as a reference	Enter the nominal frequency using the numerical keys.

3. Press ΔMODE MENU ΔMKR to make the marker a reference.
4. Press (Search) WIDTH [OFF] WIDTH VALUE.
5. Press (−) (3) (x1) to enter −3 dB.
6. Toggle WIDTH on OFF to ON off.

The sub-markers appear at a specified level down on both sides of the reference marker and the center of the two sub-markers, as shown in Figure 5-1. The bandwidth (BW), center frequency (cent), Q factor (Q), insertion loss (loss), and left and right hand bandwidth from the center frequency (ΔL.F and ΔR.F) are displayed on the upper right of the grid.

You can move the reference marker using the rotary knob. When you enable the width function, the reference marker automatically turns into a tracking Δmarker that allows you to move the reference marker.

For more information about the width function, see chapter 12 of the *Function Reference* manual.

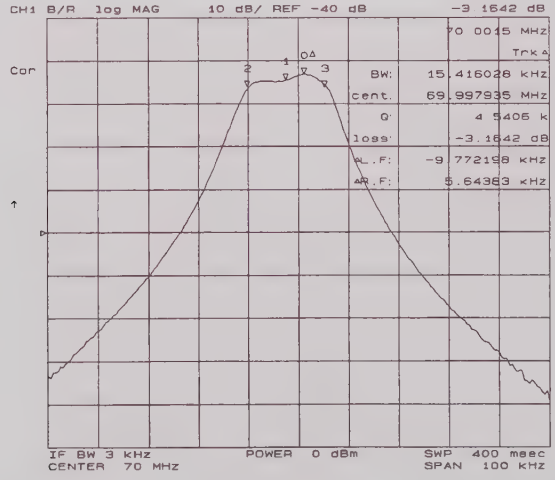


Figure 5-1.
Bandwidth Measurement Using Width Function

To Monitor the Spectrum of the Network Measurement Input

1. Press (Display). Then toggle DUAL CHAN on OFF to ON off.
2. Press (Ch 1) or (Ch 2) to activate the other channel (that is, the channel that was not used for the network measurement).
3. Press (Meas) ANALYZER TYPE.
4. Press SPECTRUM ANALYZER to set the spectrum analyzer mode.
5. Set the same frequency setting for both channels.
6. Press (Meas). Then select the input port (A or B) that you used for the network measurement.

You can monitor the spectrum of the network input without reconnecting the cables. This feature allows you to analyze the network characteristics while separating the effect of unknown signals (for example spurious signals) without performing any additional procedures.

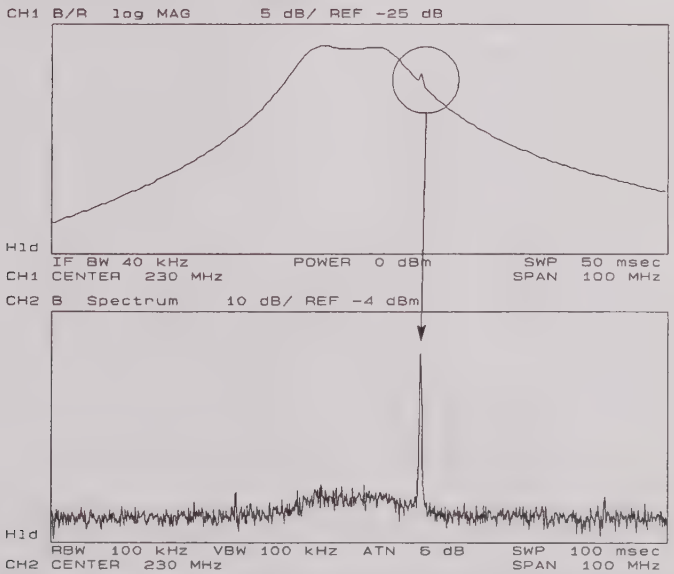
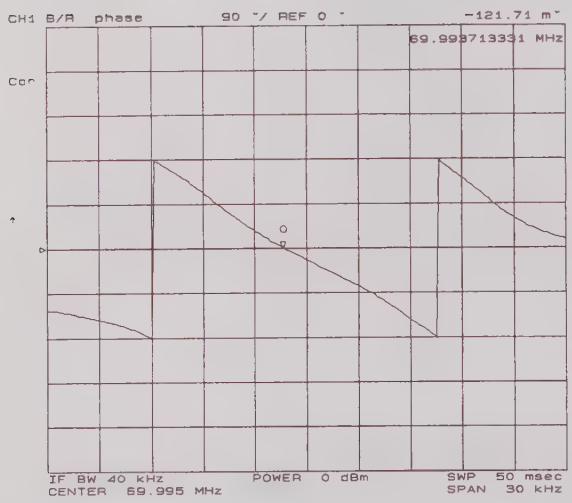

CH1 B/R log MAG 5 dB/ REF -25 dB
Hld
IF BW 40 kHz POWER 0 dBm SWP 50 msec
CH1 CENTER 230 MHz SPAN 100 MHz
CH2 B Spectrum 10 dB/ REF -4 dBm
Hld
RBW 100 kHz VBW 100 kHz ATN 5 dB SWP 100 msec
CH2 CENTER 230 MHz SPAN 100 MHz

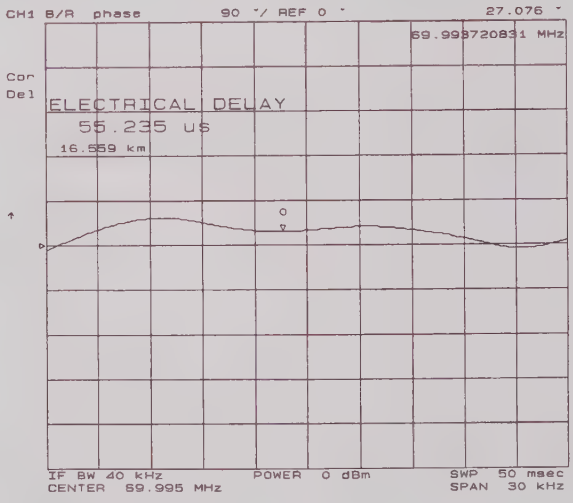
Figure 5-2. Spectrum Monitoring in the Network Measurement

To Measure the Electrical Length

1. Select the phase format.
2. Do one of the following procedure:
   - Using the marker:
     a. Press (Marker).
     b. Turn the rotary knob to position the marker at the center of the display.
     c. Press (Scale Ref) ELECTRICAL DELAY MENU.
     d. Press MKR→DELAY.
   - Using the rotary knob:
     a. Press (Scale Ref) ELECTRICAL DELAY MENU
     b. Press ELECTRICAL DELAY.
     c. Turn the rotary knob until the trace becomes flat at the interested frequency.
3. Press ELECTRICAL DELAY. Then read the electrical length that is displayed under the electrical delay time.



Before Adding the Electrical Length



After Adding the Electrical Length

Figure 5-3. Adding Electrical Length

If the average relative permitivity (ε_R) of the DUT is known over the frequency span, the length calculation can be adjusted to better indicate the actual length of the DUT. This can be done by entering the relative velocity factor for the DUT.

To Set Velocity Factor of a Cable

1. Press Cal.
2. Press MORE.
3. Press VELOCITY FACTOR.
4. Enter a new value. Then press x1.

The relative velocity factor for a given dielectric can be calculated by:

$$V_f = \frac{1}{\sqrt{\varepsilon_R}}$$

Default setting of the velocity factor is 1.

To Measure the Phase Deviation

To Display the Deviation from the Linear Phase

1. Set up the frequency range.
2. Display the phase trace by pressing (Format) PHASE .
3. Adjust the scale settings by pressing (Scale Ref) AUTO SCALE .
4. Press (Marker). Then move the marker to any of the points where the sloping trace crosses the center (place the marker on the sloping portion of the trace, not the vertical phase "wrap-around").
5. Press (Scale Ref) ELEC DELAY MENU MKR→DELAY to add enough electrical length to match the group delay present at the marker frequency.
6. Read the phase value as a deviation from the linear phase.

By adding the electrical length to flatten the phase response, the linear phase shift caused by the DUT is removed. The displayed response is the deviation from the linear phase.

To turn off the electrical length function, press (Scale Ref) ELEC DELAY MENU ELECTRICAL DELAY (0) (x1).

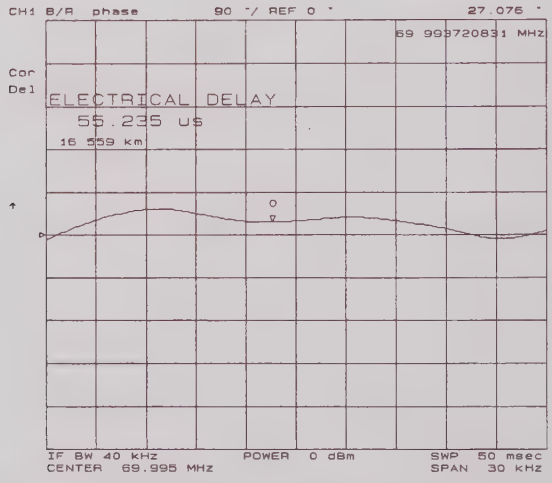


Figure 5-4. Deviation from the Linear Phase

To Display the Group Delay

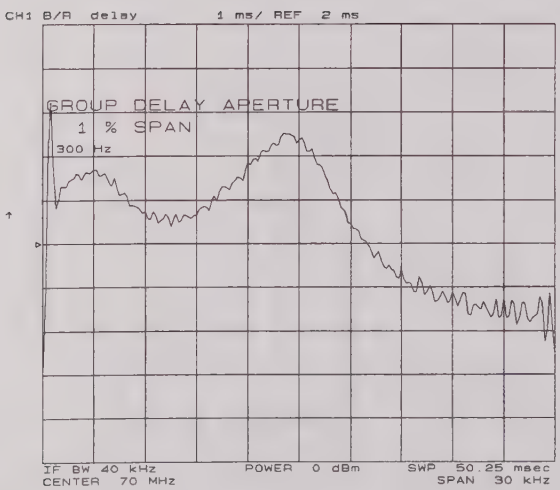
1. Press (Format).
2. Press DELAY.

The group delay format displays phase deviation to group delay aperture. Therefore, setting the group delay aperture affects the trace shape. Setting a wider aperture makes the trace smoother. The default setting of the aperture is 1% of span.

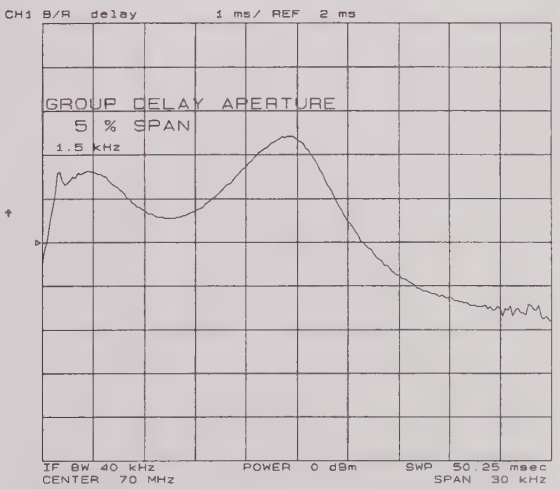
To Set the Group Delay Aperture

1. Press (Bw/Avg).
2. Press GROUP DELAY APERTURE.
3. Enter group delay aperture value as a percentage of the span.

The Group delay aperture is based on the number of points, not the real aperture. For example, if the number of points is 201, a 1% group delay aperture calculates the group delay using the adjacent measurement points on both sides. Therefore, the group delay trace is different by the number of points setting even if the group delay aperture is the same setting.



Aperture 1%



Aperture 5%

Figure 5-5. Setting Group Delay Aperture

For more information about a group delay, see chapter 12 of the *Function Reference.*

To Cancel an Extension of a Measurement Cable

If the Electrical Delay of the Extended Cable is Known

1. Press (Cal) MORE PORT EXTENSION to call the port extension menu.
2. Enter the electrical delay values for each input.
   - If you do not use the S-parameter test set:
     - Press EXTENSION INPUT R. Then enter the electrical delay of the cable that is connected to the R input.
     - Press EXTENSION INPUT A. Then enter the electrical delay of the A input.
     - Press EXTENSION INPUT B. Then enter the electrical delay of the B input.

     If you use the transmission/reflection (T/R) test set, enter the electrical delay of the cable that is connected to the TEST PORT (for the R and A inputs).

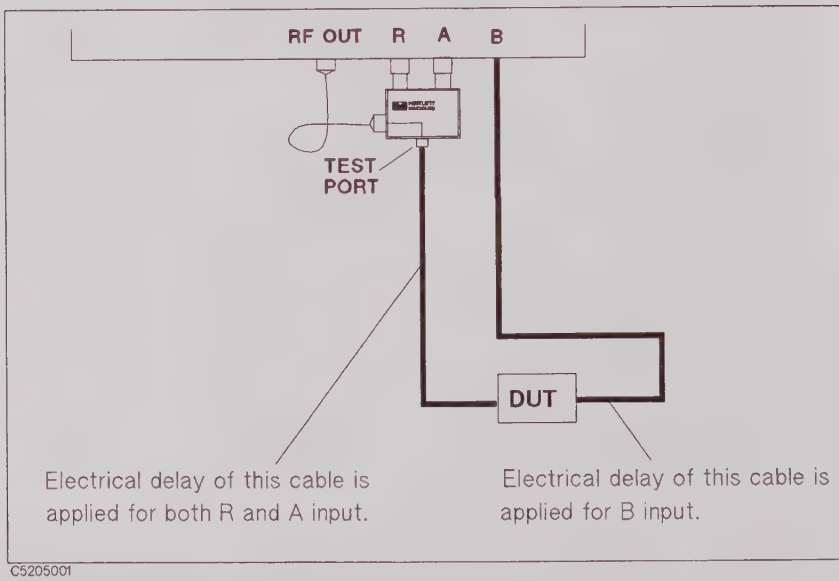


Figure 5-6. Port Extension With the T/R Test Set

- If you use the S-parameter test set:
  - Enter "0" for `EXTENSION INPUT R`, `EXTENSION A` and `EXTENSION INPUT B` to clear the port extension of the R, A and B inputs.
  - Press `EXTENSION PORT 1`. Then enter the electrical delay of the PORT 1.
  - Press `EXTENSION PORT 2`. Then enter the electrical delay of the PORT 2.

3. Toggle `EXTENSION on OFF` to `ON off` to enable the port extension.

If the Electrical Delay of the Extended Cable is Unknown

You can determine the electrical delay of the cable by following methods:

- Measuring the electrical length of the cable.
- Measuring the OPENed or SHORTed cable reflection.

Measuring the Electrical Length of the Cable

1. Connect the cable as shown in Figure 5-7.
2. Set up the frequency range to the measurement condition.
3. Press (Meas) B/R (or Trans:FWD S21 [B/R]) to select the transmission measurement.
4. Press (Format) PHASE to select the phase format.
5. Press (Marker). Then move the marker to the sloping trace that crosses the center of the display.
6. Press (Scale Ref) ELEC DELAY MENU ELECTRICAL DELAY MKR→DELAY, then read the electrical delay of the cable.
7. Press (0) (×1) to clear the electrical delay offset.
8. Enter a measured electrical delay as described in the "If the Electrical Delay of the Extended Cable is Known" procedure.

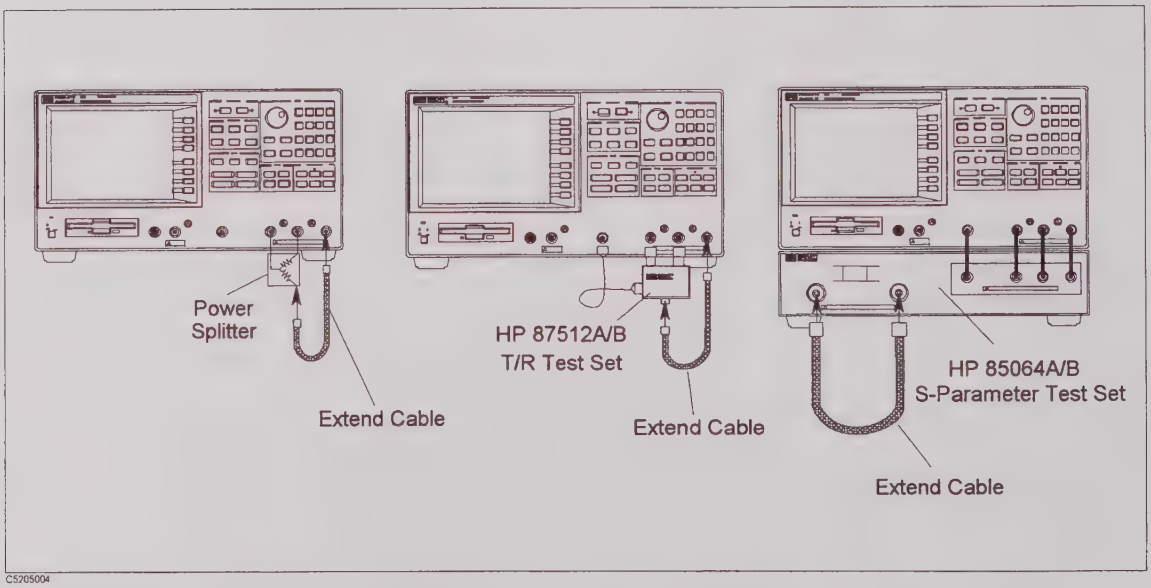


Figure 5-7. Cable Measurement Configuration

Measuring the OPENed or SHORTed Cable Reflection

1. Connect the cable as shown in Figure 5-8.
2. Set up the frequency range for the measurement condition.
3. Press (Meas) A/R (or Refl:FWD S11 [A/R]) to select the reflection measurement.
4. Press (Format) PHASE to select the phase format.
5. Press (Marker). Then move the marker to the sloping trace that crosses the center of the display.
6. Press (Scale Ref) ELEC DELAY MENU ELECTRICAL DELAY MKR→DELAY, then read the electrical delay of the cable. Note that this value is twice the real delay because there is an output and a return paths.
7. Press (0) (x1) to clear the electrical delay offset.
8. Enter *half the value* of the measured electrical delay as described in the "If the Electrical Delay of the Extended Cable is Known" procedure.

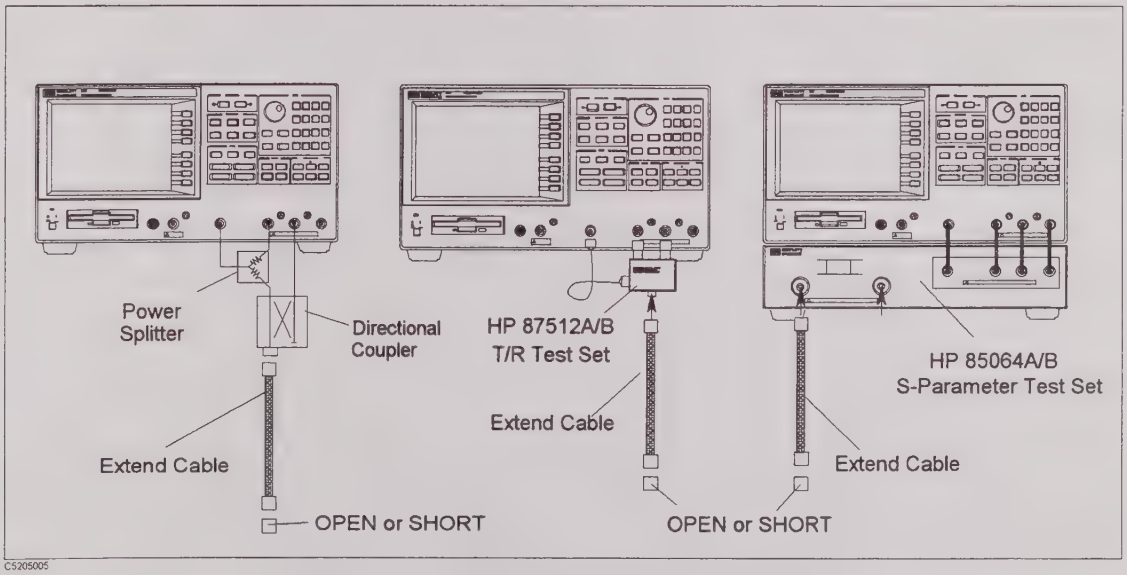


Figure 5-8. Cable Measurement Configuration

Notes For more information about Electrical delay and port extension, refer to chapter 5 of the *Function Reference*.

6

Using Features Common to Both Modes of Operation

This chapter provides procedures for the analyzer features that can be used in both the spectrum and network analyzer modes of operation.

This chapter provides the following procedures:

- To perform GO/NO-GO testing
- To offset the limit line
- To make a list sweep
- To use the trace memory
- To offset the trace
- To use the trace math functions
- To print and plot
- To save and recall

To Perform GO/NO-GO Testing

Step 1: Planning the Limit Lime

1. Determine the following parameters before editing the limit line:

Parameter	Description
Sweep Parameter	Frequency of each segment.
Upper Limit	Upper limit level of each segment.
Lower Limit	Lower limit level of each segment.

The limit line is constructed by connecting the segment points as shown in Figure 6-1.

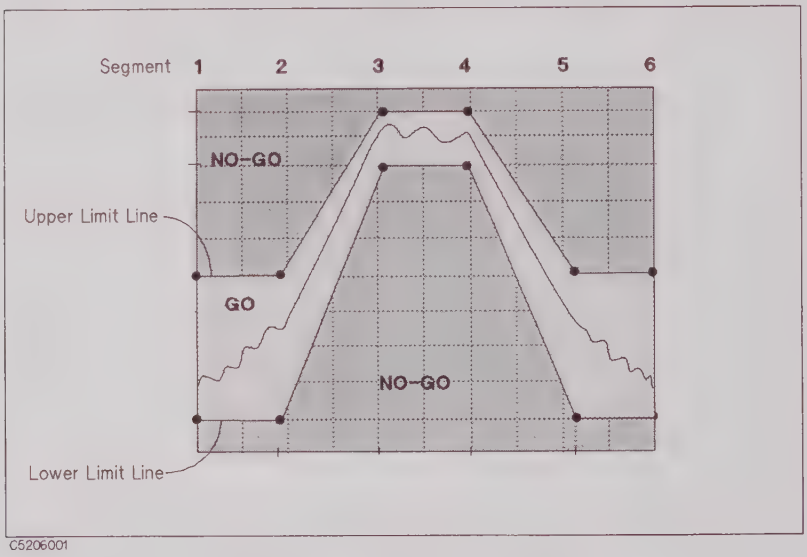


Figure 6-1. Limit Line Image

For example, if you want to specify four points for the limit test, the limit line image is as shown in Figure 6-2. Each point has frequency information and an upper and a lower limit value. Enter these values as described in the "Step 2: Editing a Limit Line Table" procedure.

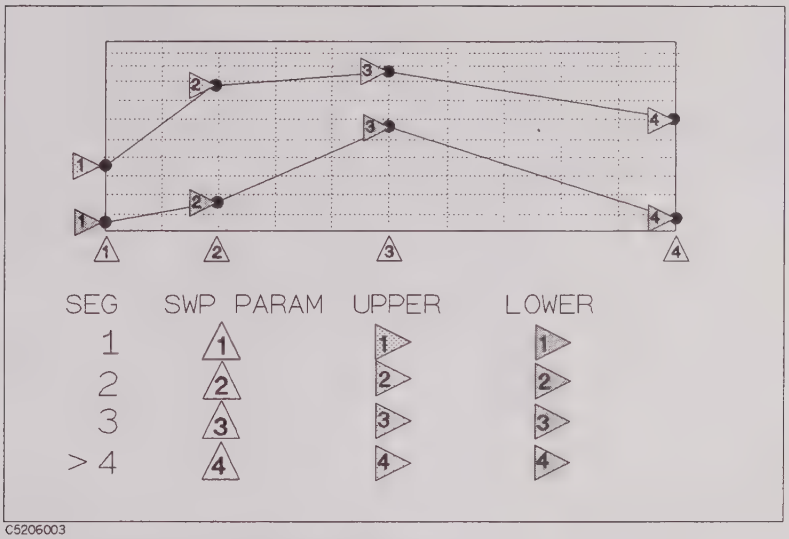


Figure 6-2. Frequency, Upper and Lower Limit

In this example, the limit line connects four limit points. If a measured trace exceeds the upper or lower limit line, the limit test fails.

Step 2: Editing a Limit Line Table

1. Set up the frequency range of the grid before starting the limit line edit.
2. Press System.
3. Press `LIMIT MENU`. Then toggle `LIMIT LINE` on `OFF` to `ON`. This makes it easier to understand the status of the limit line while you are editing it.
4. Press `EDIT LIMIT LINE` to call the limit line editor.
5. If an old limit line table is still in the limit line editor, press `CLEAR LIST` `CLEAR LIST YES` to clear it.
6. Press `EDIT` to edit the first segment.

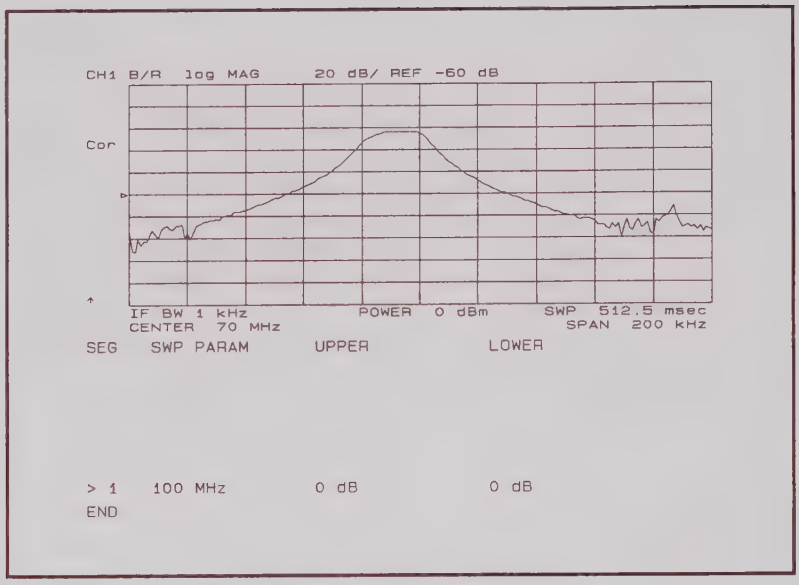


Figure 6-3. Limit Line Editor

7. Enter the frequency of the segment in one of the following ways:
   - Press SWP PARAM. Then enter the frequency of the segment.
   - Move the marker to the point you want to use as the frequency of the segment. Then press MKR→SWP PARAM.
8. Press UPPER LIMIT. Then enter a upper limit value.
9. Press LOWER LIMIT. Then enter a lower limit value.
10. Press DONE to end editing the segment.
11. Press ADD to edit the next segment.
12. Repeat list item 7 to list item 11 until all segments are defined.
13. When you finish editing all segments, press DONE to complete editing the limit line table.

You can enter the limit value using the middle and width method by pressing MIDDLE VALUE and DELTA LIMIT. You then enter the amplitude value as a middle amplitude value with a delta limit. The upper and lower limit lines appear at an equal positive and negative distance from the specified middle amplitude.

To Modify or Delete the Segment

1. Press SEGMENT.
2. Select the segment you want to delete or modify:
   - Enter the segment number you want to modify. Then press (x1).
   - Move cursor, ">", to the segment you want to modify by using the (↑), the (↓), or the knob.
3. Do either of the following:

To	Press
Modify specified segment	EDIT
Delete specified segment	DELETE

Step 3: Executing a Limit Line Test

To Make a Limit Line Test Active

1. Press (System).
2. Press LIMIT MENU.
3. Toggle LIMIT TEST on OFF to ON off.

If the limit line test passes, a green PASS message appears on the right of the grid. If it fails, a red FAIL message is displayed. You can set the analyzer to beep if the limit line test fails. (See the "To Beep When the Limit Test is Failed" procedure.)

Figure 6-4. Limit Line Test

To Beep When the Limit Test is Failed

1. Press (System).
2. Press LIMIT MENU.
3. Toggle BEEP FAIL on OFF to ON off.

Notes You can save the edited limit line table with all other instrument settings by pressing (Save) STATE. See "To Save an Analyzer Setting or Measurement Data" for more information.

To Offset the Limit Line

1. Press (System) LIMIT MENU .
2. Press LIMIT LINE OFFSETS .
3. Press the following keys:

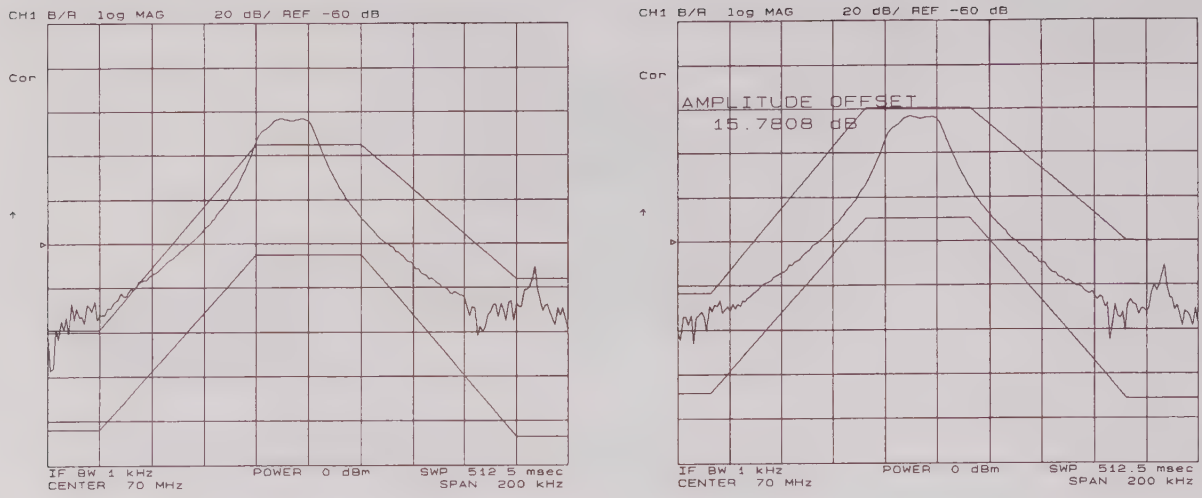
To move line	Press
Horizontally	SWP PARAM OFFSET
Vertically	AMPLITUDE OFFSET

4. Then move the limit line by entering an offset value using one of the following:

To	Use
Move continuously	
Move with steps	(↑) (↓)
Enter offset value directly	(0) ... (9) and unit keys

5. To move the limit line vertically to the marker position:
   a. Press (Marker) Then move the marker to the point you want to set as the offset value.
   b. Press (System) LIMIT LINE MENU LIMIT LINE OFFSETS MKR→ AMP. OFS. .
6. When you are finished offsetting the limit line, press RETURN .

To Offset the Limit Line



Before Offset

After Offset

Figure 6-5. Offsetting Limit Lines

To clear the offset, enter 0 for all the offset values.

To Make a List Sweep

Step 1: Planning the List Sweep

1. Determine the following parameters before editing the sweep list.

Parameter	Description
Sweep Parameter	Frequency (or power for the power sweep) of each segment. Each segment cannot be continuous. You can reduce the sweep time by setting the segment only for the required part of the trace.
Number of points	Number of display points. You can adjust the display area for each segment by setting this parameter.
RBW	This parameter is for the spectrum analyzer mode. You can set the resolution bandwidth for the each segment individually. This is useful if you want to display higher resolution only for the specific segment.
IF BW	This parameter for the network analyzer mode. You can set the IF bandwidth for each segment individually. This is useful if you want to display higher dynamic range only for the specific segment.
Output Power	Output power from the RF OUT port of each segment. The allowable range is -70 dBm to +20 dBm. When you want to use the internal tracking generator for spectrum measurement, you can set this parameter in the spectrum analyzer mode. *

* RBW≥10 kHz only.

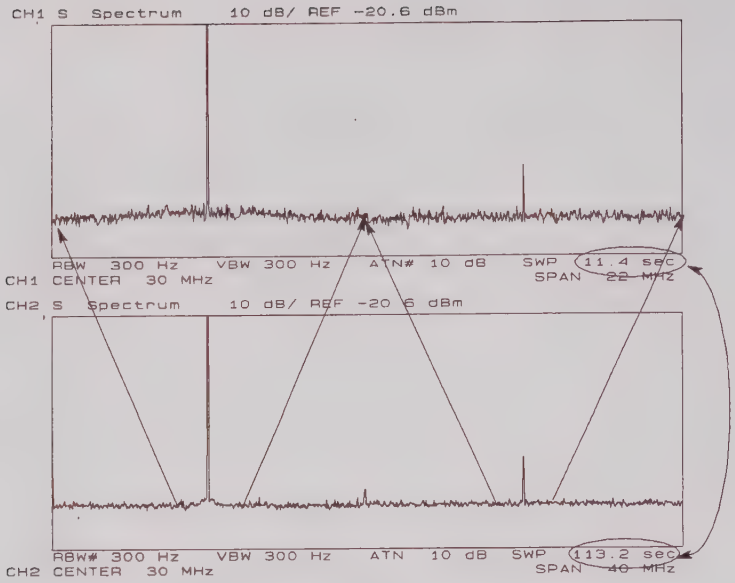

CH1 S Spectrum 10 dB/ REF -20.6 dBm
RBW 300 Hz VBW 300 Hz ATN# 10 dB SWP 11.4 sec
CH1 CENTER 30 MHz SPAN 22 MHz
CH2 S Spectrum 10 dB/ REF -20.6 dBm
RBW# 300 Hz VBW 300 Hz ATN 10 dB SWP 113.2 sec
CH2 CENTER 30 MHz SPAN 40 MHz

Figure 6-6. List Sweep (Upper) Reduces Sweep Time

Step 2: Editing a Sweep List

1. Press (Sweep) `SWEEP TYPE MENU EDIT LIST` to call the sweep list editor.
2. Press `EDIT` to edit the sweep list.

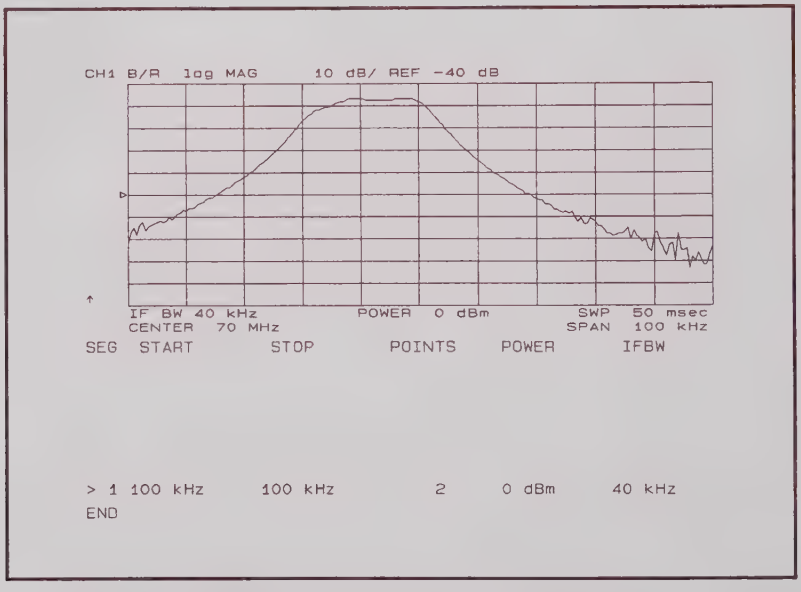

CH1 B/R log MAG 10 dB/ REF -40 dB
IF BW 40 kHz POWER 0 dBm SWP 50 msec
CENTER 70 MHz SPAN 100 kHz
SEG START STOP POINTS POWER IFBW
> 1 100 kHz 100 kHz 2 0 dBm 40 kHz
END

Figure 6-7. List Sweep Editor

3. Enter the frequency (or power) range of the segment.

- Move the marker to the start point. Then press SEGMENT: MKR→START.
- Move the marker to the stopping point. Then press MKR→STOP.
- Press Start to enter the start sweep parameter. Then press Stop to enter the stop sweep parameter.

4. Press NUMBER of POINTS. Then enter the number of points for the segment.
5. Set the output power:
   - When in spectrum analyzer mode, ignore this parameter unless you are using the internal tracking generator. The default value (0 dBm) is not applied until you turn on the RF Output.
   - Press POWER. Then enter the output power level for the segment.
6. Set the internal filter bandwidth:
   - When in spectrum analyzer mode, press RES BW to set the resolution bandwidth.
   - When in network analyzer mode, press IF BW to set the IF bandwidth.
7. Press SEGMENT DONE to complete editing the segment.
8. Press ADD to edit the next segment.
9. Repeat list item 3 to list item 8 until you complete editing of all required segments.
10. When you finish editing all the segments, press LIST DONE to complete the sweep list.

To Modify or Delete the Segment

1. Press SEGMENT.
2. Select the segment you want to delete or modify:
   - Enter the segment number you want to modify. Then press x1.
   - Move the cursor, ">", to the segment you want to modify by using the ↑, the ↓, or the knob.
3. Do either of the following:

To	Press
Modify specified segment	EDIT
Delete specified segment	DELETE

Step 3: Activating the List Sweep

1. Press (Sweep).
2. Press SWEEP TYPE MENU.
3. Press LIST FREQ.
4. If you use the output power in the spectrum analyzer mode, press (Source). Then toggle RF OUT on OFF to ON off.

Notes

If you want to delete an edited sweep list, press (Sweep) SWEEP TYPE MENU EDIT LIST CLEAR LIST CLEAR LIST YES.

You can save and recall the edited sweep list with all other instrument settings by pressing (Save) STATE. See "To Save an Analyzer Setting or Measurement Data" for more information.

For more information about the list sweep, see chapter 6 of the *Function Reference*.

To Use the Trace Memory

Step 1: To Store the Trace into the Trace Memory

1. Display the trace you want to store into the trace memory.
2. Press (Display).
3. Press DATA→MEMORY.

This operation only stores the digitized trace data into the trace memory (not the display on CRT). You can store the trace data for the trace memory of each channel individually. The stored trace data is retained until new data is stored, the analyzer is preset, or power is turned off.

Step 2: To Display Memory Traces

1. Press (Display).
2. Select the display trace:

To display	Press
Memory trace	MEMORY
Data and memory trace together	DATA and MEMORY
Data trace	DATA

Memory traces are displayed as green (channel 1) or red (channel 2) to distinguish between the two traces. You can change this color by using the modify colors menu under (Display) MORE ADJUST DISPLAY.

If the trace memory of the active channel is empty, the error message (CAUTION: NO VALID MEMORY TRACE) is displayed.

Notes The scale of the memory trace is coupling with the data trace. If you want to change the scale setting for only the data or memory trace, toggle (Scale Ref) D&M SCALE [COUPLE] to [UNCOUPLE]. Then toggle SCALE FOR [DATA] or [MEMORY] before you change the settings.

For more information about trace memory, see chapter 5 of the *Function Reference*.

To Offset the Trace

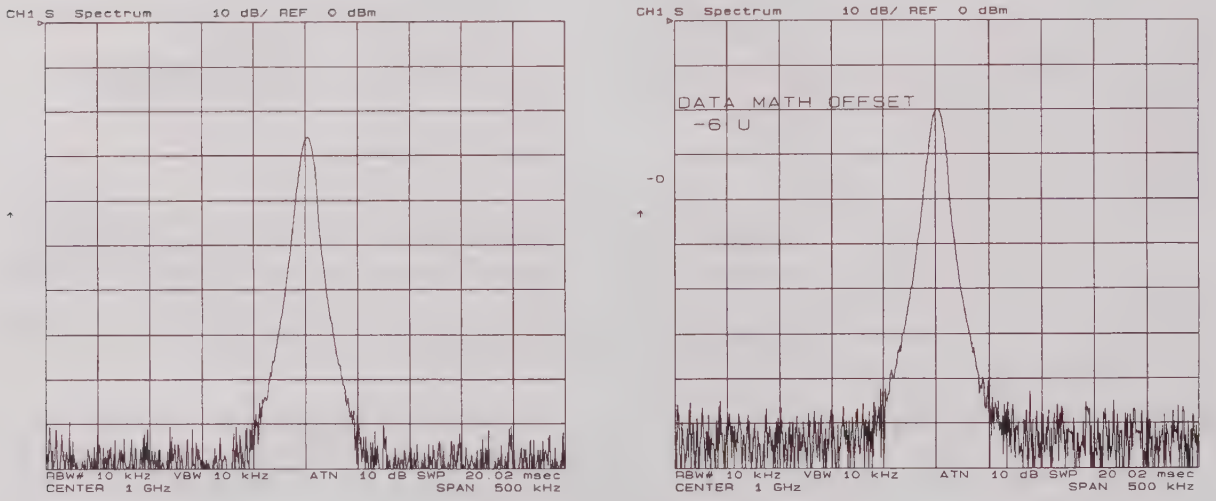
1. Press Display.
2. Press DATA MATH [DATA] .
3. Press OFFSET . Then enter the offset value.

To	Press
Set the marker position to the offset value	MKR→OFFSET
Enter the offset value directly	OFFSET . Then enter the offset value

4. Press RETURN .

For example, if an attenuator is inserted between a signal source and the input port of the analyzer, the offset function corrects the attenuation of the input signal and displays the trace referenced to the input signal to the attenuator.

Offset indicator, -O, appears on the left side of the grid.


CH1 S Spectrum 10 dB/ REF 0 dBm
RBW# 10 kHz VBW 10 kHz ATN 10 dB SWP 20.02 msec
CENTER 1 GHz SPAN 500 kHz
CH1 S Spectrum 10 dB/ REF 0 dBm
DATA MATH OFFSET
-6 U
-O
RBW# 10 kHz VBW 10 kHz ATN 10 dB SWP 20.02 msec
CENTER 1 GHz SPAN 500 kHz

6 dB Attenuated Signal

After Offset

Figure 6-8. Offsetting the Trace

To Clear the Offset

1. Press Display.
2. Press DATA MATH [DATA-O] .
3. Press DEFAULT GAIN & OFS .

Notes

For more information about offsetting and multiplying traces, see the *Function Reference*.

To Use the Trace Math Function

1. Press (Display).
2. Press DATA MATH [DATA] .
3. Do one of the following:

To	Press
Add Trace with Memory Trace	DATA+MEM
Subtract Trace with Memory Trace	DATA-MEM
Divide Trace with Memory Trace	DATA/MEM

To Turn Off the Data Math Function

1. Press (Display).
2. Press DATA MATH .
3. Press DATA MATH: DATA .

To Multiply the Trace

1. Press (Display).
2. Press DATA MATH [DATA] .
3. Press GAIN . Then enter a multiplication factor:

To	Use
Change value continuously	
Change value with 1-2-5 steps	(⇧) (⇩)
Enter value directly	(0) . . . (9) and unit keys

To Clear a Multiplied Trace

1. Press (Display).
2. Press DATA MATH [G*DATA] .
3. Press DEFAULT GAIN & OFS .

To Print

This step provides the following procedures for printing:

- To print out a display image
- To see or print a measured value list
- To print an analyzer setting

To Print Out a Display Image

1. Connect the printer to the analyzer with a cable.
2. Press (Copy) `PRINT [STANDARD]` to print out a display image.

To See or Print a Measured Value List

1. Press (Copy).
2. Press `MORE LIST VALUES` to display the measured value list.
   - To see all of the measured value list, press `NEXT PAGE` or `PREV PAGE` to turn the pages.
   - To print out the measured value list, press `PRINT [STANDARD]` .
   - To return to the measurement display, press `RESTORE DISPLAY` .

To Print an Analyzer Setting

1. Press (Copy).
2. Press MORE OPERATING PARAMETERS to display the analyzer setting table as shown below.
3. Press PRINT [STANDARD] to print out the settings.
4. To return to the measurement display, press RESTORE DISPLAY .

Analyzer Setting Table

OPERATING PARAMETER	CH1	CH2
ANALYZER TYPE	NA	NA
SWEEP TYPE	LIN FREQ	LIN FREQ
NUMBER of POINTS	201	201
RF OUT	ON	ON
PORT 1 ATTEN.	0 dB	0 dB
PORT 2 ATTEN.	0 dB	0 dB
GROUP DELAY APERTURE	1 % SPAN	1 % SPAN
PHASE OFFSET	0 °	0 °
PORT 1 EXTENSION	0 s	0 s
PORT 2 EXTENSION	0 s	0 s
INPUT R EXTENSION	0 s	0 s
INPUT A EXTENSION	0 s	0 s
INPUT B EXTENSION	0 s	0 s
	OFF	OFF
VELOCITY FACTOR	1	1
CAL KIT	7mm	7mm
Z0	50 ohm	50 ohm
CAL TYPE	NONE	NONE

To Save and Recall

This step provides the following procedures for saving and recalling:

- To save an analyzer setting or measurement data
- To recall a saved analyzer setting
- To save a display image to a TIF file
- To save measured data for a spreadsheet
- To copy the file
- To initialize a disk for use
- To initialize the RAM disk for use

To Save an Analyzer Setting or Measurement Data

1. Insert a LIF or DOS formatted 3.5 inch disk into the built-in disk drive (if you are recalling an instrument state file from the RAM disk, skip this step).
2. Press (Save).
3. Select a save data type:

Save Data Type	Press
Instrument states only	STATE
Measurement data only[1]	DATA ONLY (binary)

1 You can specify a data array type. See the "To Specify a Data Array Type" procedure.

4. Select where the file is stored by pressing either
   STOR DEV [DISK] (for the built-in disk drive) or
   STOR DEV [MEMORY] (for the RAM disk).
5. Enter a filename. Then press DONE.

The analyzer automatically detects the disk format as either the LIF (Logical Interchange Format) or DOS (Disk Operating System). If you insert an any other format type disk, an error message is displayed.

For more information, appendix C of the *Function Reference* provides a complete list of the instrument state to be saved.

Note

You can automatically recall the instrument state every time the analyzer is turned ON. Use "AUTOREC" as a filename. The analyzer recalls this file from a disk that is inserted in the built-in disk drive when it is turned ON.

To Specify a Data Array Type

1. Press (Save) DEFINE SAVE DATA .
2. Toggle to ON off the item what you want to save:

Data array	Toggle
Raw data array	RAW on OFF to ON off
Calibration data array	CAL on OFF to ON off
Data array	DATA on OFF to ON off
Memory array	MEM on OFF to ON off
Data Trace array	DATA TRACE on OFF to ON off
Memory Trace array	MEM TRACE on OFF to ON off

3. Press RETURN to return to the top menu.

To Recall a Saved Analyzer Setting

1. Insert a disk (if you are recalling an instrument state file from the RAM disk, skip this step).
2. Press (Recall).
3. Select where the file is stored by pressing either STOR DEV [DISK] (for a built-in disk drive) or STOR DEV [MEMORY] (for a RAM disk).
4. Search for the filename you want to recall (the files are listed on the softkey label).
5. If a target file is not listed on the softkey label, turn the label page by pressing PREV FILES or NEXT FILES .
6. Press the softkey corresponding to the filename label.

To Save a Display Image to a TIFF File

1. Press (Save) GRAPHICS .
2. Select where to store the file by pressing either STOR DEV [DISK] (for a built-in disk drive) or STOR DEV [MEMORY] (for a RAM disk).
3. Enter filename. Then press DONE .

The analyzer saves a TIFF file with an extension, ".TIF" for a DOS format, or a suffix, "_T" for a LIF format.

If there is a file that has the same name you entered on the disk, the error message, "filename error" will be displayed. To save the file, use the other filename to save or purge the old file. To purge a file, press (Save) FILE UTILITIES PURGE FILE then select the displayed filename by pressing the associated softkey.

To Save Measured Data for a Spreadsheet

1. Insert a DOS format disk into the built-in disk drive.
2. Press (Save) `DATA ONLY`.
3. Press `SAVE ASCII`.
4. Select the built-in disk drive as the storage device by toggling to `STOR DEV [DISK]`.
5. Enter a filename. Then press `DONE`.

The analyzer saves an ASCII file with a "`.TXT`" extension.

The measured data is saved as ASCII text. Each value is separated by a tab. When you open this file from the spreadsheet software, specify the file format as the "TEXT with TAB delimiter".

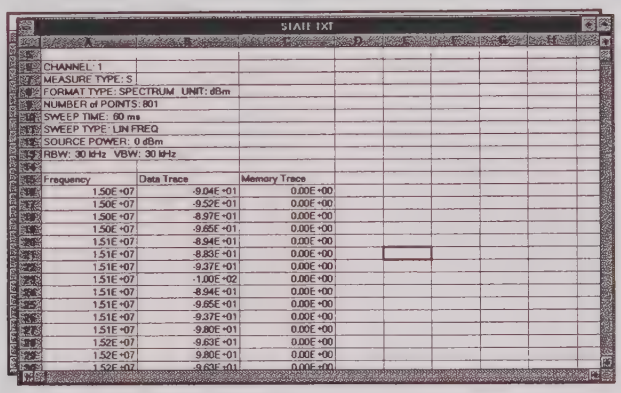


Figure 6-9. Reading Saved Data from Spreadsheet Software

To Copy the File

1. Press (Save) FILE UTILITIES.
2. Press COPY FILE.
3. Select a storage device where the file is stored by toggling either STOR DEV [DISK] (for the build-in disk drive) or STOR DEV [MEMORY] (for the RAM disk).
4. Search for the filename you want to recall (the files are listed on the softkey label).
5. If a target file is not listed on the softkey labels, turn the label page by pressing PREV PAGE or NEXT PAGE.
6. Press the softkey corresponding to the filename label.
7. Enter the filename of the target file.
8. Select the target storage device by toggling STOR DEV [DISK] or [MEMORY].
9. Press DONE to copy the file.

You cannot copy a file between the LIF and DOS formats. When you want to copy a file on a DOS formatted disk to the RAM disk, you must initialize the RAM disk to the DOS format.

To Initialize a Disk for Use

Note

Initializing the disk erases all data on the disk.

1. Verify that the disk is not write protected.
2. Insert the disk.
3. Press (Save) FILE UTILITIES.
4. Select the disk format (either DOS or LIF) by toggling FORMAT [DOS] or [LIF].
5. Toggle to STOR DEV [DISK] to select the disk drive.
6. Press INITIALIZE.
7. Press INITIALIZE DISK: YES to initialize the disk.

To Initialize the RAM Disk for Use

Note Initializing the RAM disk erases all data on the RAM disk.

1. Press (Save) `FILE UTILITIES` .
2. Select the disk format (either DOS or LIF) by toggling `FORMAT [DOS]` or `[LIF]` .
3. Toggle to `STOR DEV [MEMORY]` to select the RAM disk.
4. Press `INITIALIZE` `INITIALIZE MEMORY: YES` .

The files on the RAM disk are kept until the analyzer is turned off. When the analyzer is turned off, the data on the RAM disk is lost.

The format is retained in the backup memory. The analyzer initializes the RAM disk automatically every time it is turned ON (using the format in the backup memory).

Notes For more information about saving data, see chapter 8 of the *Function Reference*.

Manual Changes

Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the HP 4396B than the current printing date of this manual. The information in this manual applies directly to the HP 4396B serial number prefix listed on the title page of this manual.

Manual Changes

To adapt this manual to your HP 4396B, see Table A-1 and Table A-2, and make all the manual changes listed opposite your instrument's serial number and firmware version.

Instruments manufactured after the printing of this manual may be different from those documented in this manual. Later instrument versions will be documented in a manual changes supplement that will accompany the manual shipped with that instrument. If your instrument's serial number or ROM version is not listed on the title page of this manual, in Table A-1, or Table A-2, make changes according to the *yellow MANUAL CHANGES* supplement.

In additions to information on changes, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest *MANUAL CHANGES* supplement.

For information concerning serial number prefixes not listed on the title page or in the *MANUAL CHANGE* supplement, contact the nearest Hewlett-Packard office.

To confirm the firmware version, turn ON the power for the HP 4396B or execute `*IDN?` on the external controller.

Table A-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes

Table A-2. Manual Changes by ROM Version

Version	Make Manual Changes

Serial Number

Hewlett-Packard uses a two-part, ten-character serial number that is stamped on the serial number plate (see Figure A-1) attached to the rear panel. The first five characters are the serial prefix and the last five digits are the suffix.

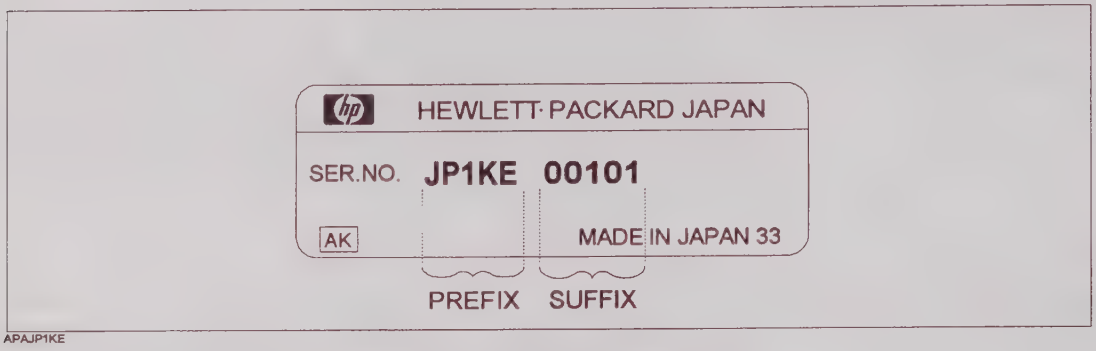


Figure A-1. Serial Number Plate

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Mar. 1996 P/N 16000-99004

HP 4396B Network/Spectrum Analyzer

Using HP Instrument BASIC with the HP 4396B

Printed in JAPAN March 1997

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Manual Printing History

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March 1997 ..... First Edition

Typeface Conventions

Bold	Boldface type is used when a term is defined. For example: **icons** are symbols.
Italics	Italic type is used for emphasis and for titles of manuals and other publications. Italic type is also used for keyboard entries when a name or a variable must be typed in place of the words in italics. For example: `copy` *filename* means to type the word `copy`, to type a space, and then to type the name of a file such as `file1`.
`Computer`	Computer font is used for on-screen prompts and messages.
HARDKEYS	Labeled keys on the instrument front panel and furnished keyboard are enclosed in ▢.
SOFTKEYS	Softkeys located to the right of the LCD are enclosed in ▒.

How to Use This Manual

This guide will help you learn how to effectively use HP Instrument BASIC (IBASIC) of the HP 4396B Network/Spectrum Analyzer. It will help you to perform typical operations involving program creation, editing, and execution. It will also show you how to save and recall programs, and how to make the best use of the HP Instrument BASIC's front-panel and keyboard interface. Here is a brief guide to help you locate the necessary information in this manual.

- Chapter 2 introduces the analyzer's HP Instrument BASIC system and describes how to connect and use a keyboard.
- Chapter 3 and Chapter 4 show creating, getting, and saving programs to teach you front panel and keyboard operation.
- Chapter 5 introduces you to the editing environment.
- Chapter 6 provides application programs and useful techniques for developing programs.
- Chapter 7 describes interfacing features for graphics, external connector to trigger RUN/CONTinue of a program, and I/O port.
- Chapter 8 introduces special features for auto loading a program, and the On Key Label function (softkeys defined in a program). This chapter also describes techniques for speeding up your programs.
- Chapter 9 summarizes the unique features specified for the analyzer.
- Appendix A contains the information required to adept this manual to earlier versions or configurations of the analyzer than the current printing date of this manual.
- Appendix B provides references for BASIC commands specific to the analyzer's HP Instrument BASIC.
- Appendix C provides a handy reference guide to the analyzer's HP Instrument BASIC's key definitions for the mini-DIN keyboard.
- Appendix D describes the softkeys that are used for the HP Instrument BASIC operations.

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1

Welcome to HP Instrument BASIC

This guide will help you learn how to effectively use HP Instrument BASIC (IBASIC) of the HP 4396B Network/Spectrum Analyzer. It will help you to perform typical operations involving program creation, editing, and execution. It will also show you how to save and recall programs, and how to make the best use of the HP Instrument BASIC's front-panel and keyboard interface.

If you are new to programming or to HP's dialect of BASIC, take the time to read this guide and perform the exercises. For many users, this will provide all the information that is needed to create and run programs.

How to Use This Manual

The tasks in each chapter, when performed in sequential order, demonstrate a typical use of HP Instrument BASIC and cover the most common tasks. Read the overview and try the sample tasks in each chapter to get you started. For more background information, you can read further into each chapter; otherwise, go to the next exercises and continue the session. You can refer back to the individual chapters for more information as necessary. Here is a brief guide to help you locate the necessary information in this manual and the other HP Instrument BASIC manuals.

- Chapter 2 introduces the analyzer's HP Instrument BASIC system and describes how to connect and use a keyboard.
- Chapter 3 and Chapter 4 show creating, getting, and saving programs to teach you front panel and keyboard operation.
- Chapter 5 introduces you to the editing environment.
- Chapter 6 provides application programs and useful techniques for developing programs.
- Chapter 7 describes interfacing features for graphics, external connector to trigger RUN/CONTinue of a program, and I/O port.
- Chapter 8 introduces special features for auto loading a program, and the On Key Label function (softkeys defined in a program). This chapter also describes techniques for speeding up your programs.
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- Appendix B provides references for BASIC commands specific to the analyzer's HP Instrument BASIC.
- Appendix C provides a handy reference guide to the analyzer's HP Instrument BASIC's key definitions for the mini-DIN keyboard.
- Appendix D describes the softkeys that are used for the HP Instrument BASIC operations.

Note

You should become familiar with the operation of the analyzer before attempting to control it using HP Instrument BASIC. See the following documents that are better suited to this task.

User's Guide
Task Reference
Function Reference
HP-IB Programming Guide
HP-IB Command Reference
HP Instrument BASIC Users Handbook

Note

This manual, *Using HP Instrument BASIC with the HP 4396B* , is not intended to teach the HP Instrument BASIC programming language; see the following document which is better suited to these tasks.

HP Instrument BASIC Users Handbook

The handbook consists of the following three parts:

HP Instrument BASIC Programming Techniques
HP Instrument BASIC Interfacing Techniques
HP Instrument BASIC Language Reference

IF you want to port HP 9000 Series 200/300 BASIC programs to HP Instrument BASIC, see Chapter 10, "Keyword Guide to Porting," in the *HP Instrument BASIC Programming Techniques.*

2

Introduction to the System

This chapter introduces the analyzer's HP Instrument BASIC (IBASIC) and describes how to connect and use a keyboard. Read this chapter before using HP Instrument BASIC with the analyzer for the first time. The topics covered in this chapter are:

- Overview of HP Instrument BASIC
- Connecting the keyboard
- Using HP Instrument BASIC for the first time
- Using the keyboard
- Entering BASIC Statements from the front panel keys

Overview of HP Instrument BASIC

HP Instrument BASIC (IBASIC) can be used for a wide range of applications from simple recording and playback of measurement sequences to remote control of other instruments.

HP Instrument BASIC is a complete system controller residing inside your analyzer. It communicates with your analyzer via HP-IB commands and can also communicate with other instruments, computers, and peripherals over the HP-IB interface.

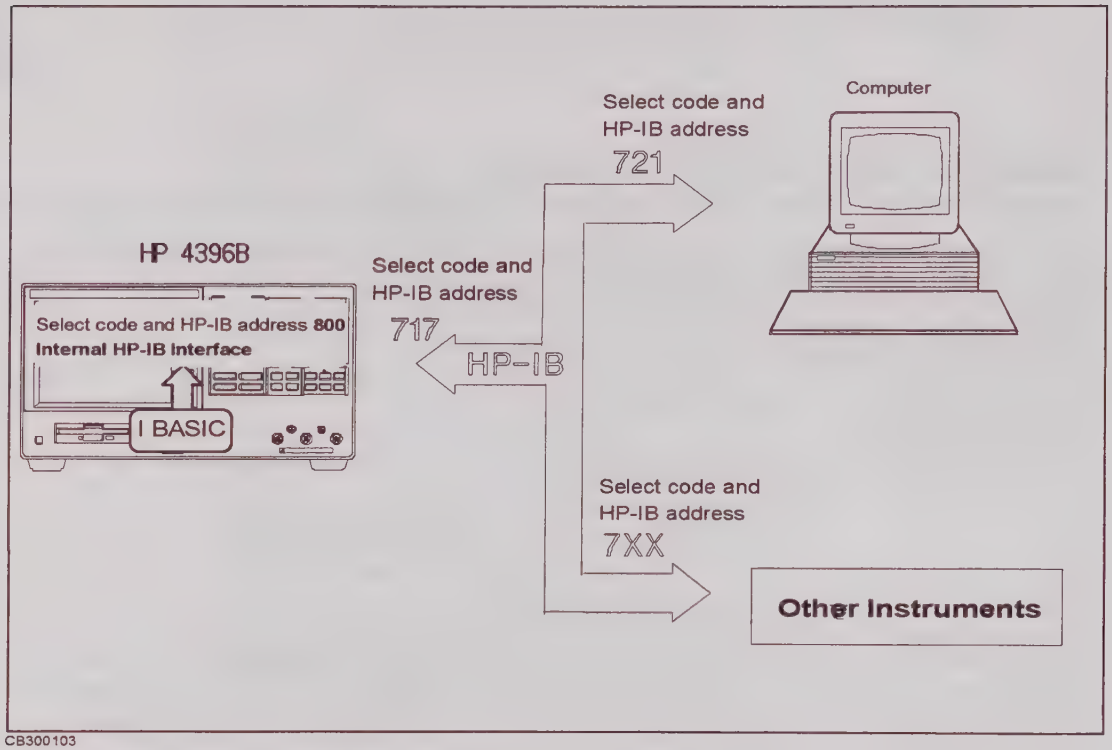


Figure 2-1. Configuration Example of the HP Instrument BASIC System

The HP Instrument BASIC's programming interface includes an editor and a set of programming utilities. The utilities allow you to perform disk I/O, renumber, secure, or delete all or part of your program.

The HP Instrument BASIC command set is similar to the command set of HP 9000 Series 200/300 BASIC. Therefore, HP Instrument BASIC programs can be run on any HP BASIC workstation with few if any changes. Porting information can be found in the *HP Instrument BASIC Programming Techniques* of the *HP Instrument BASIC Users Handbook.*

Connecting the Keyboard

Note Turn OFF the analyzer before inserting or removing the keyboard connector.

When you use HP Instrument BASIC, connect the furnished keyboard to the mini-DIN connector on the rear panel.

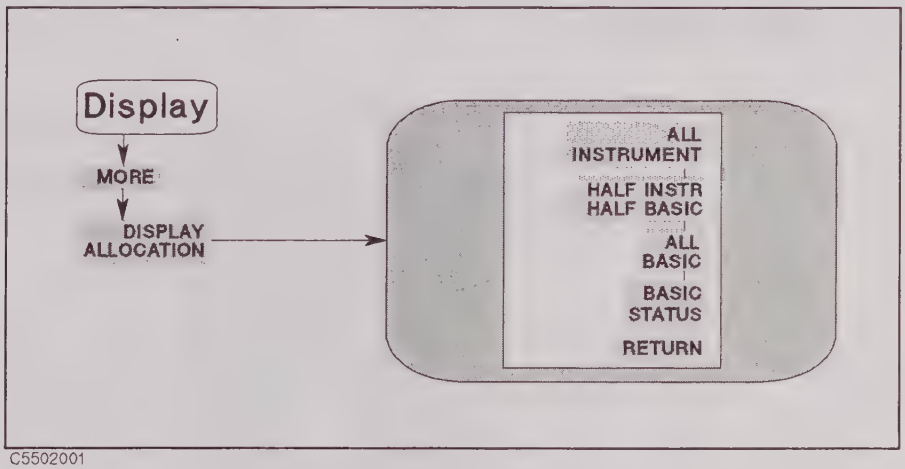
Allocating Screen Area for HP Instrument BASIC

Because all of the analyzer's screen is allocated for analyzer operation after power ON, you must allocate screen area for HP Instrument BASIC when you want to use it. The analyzer provides four display allocation types. Select one of them using `DISPLAY ALLOCATION` under (Display).

Let's try

1. Press the following key and softkeys:

   (Display) `MORE` `DISPLAY ALLOCATION`



2. Press the following softkey.

   `ALL BASIC`

   The screen is cleared and all of the screen area is allocated for HP Instrument BASIC.

3. Press the following softkey.

   `ALL INSTRUMENT`

   The total screen area is reallocated as the analyzer display.

4. Press the following softkey:

   `HALF INSTR HALF BASIC`

   The screen area is allocated so that the upper half of the screen is used for the analyzer operation and the lower half is used for HP Instrument BASIC.

5. Press the following softkey:

   `BASIC STATUS`

   Three blank lines appear at the display line (lower area of the screen). This area is used by HP Instrument BASIC to input commands and to display messages.

More information on the display allocations for the HP Instrument BASIC area is described in "Display" in Appendix D.

Setting the Size of Memory Area for HP Instrument BASIC

The size of the memory areas for the RAM disk memory and the variable of HP Instrument BASIC (excluding common variables) can be changed according to your application.

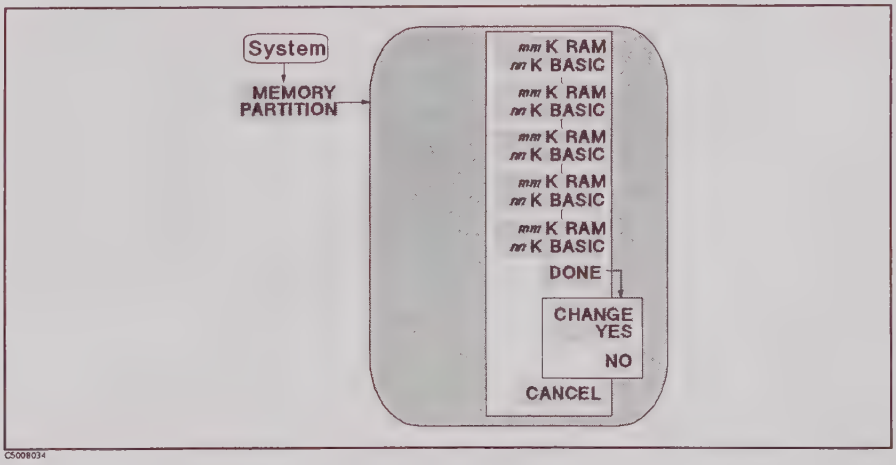
Caution

When the memory partition is reconfigured, the analyzer goes to the initial settings. That is, the RAM disk memory is initialized and all the data saved in the RAM disk memory is destroyed, and the program on the BASIC editor is destroyed.

Let's try

1. Press the following key and softkey.

   System MEMORY PARTITION



2. Press the desired softkey and DONE.

3. CHANGE YES and NO softkey labels are displayed.

   Press CHANGE YES to change the memory partition.

   Press NO to cancel changing the memory partition.

Using the Keyboard

What can the Keyboard be Used for?

The mini-DIN keyboard can be used as follows:

- Performing calculations
- Entering arguments to the active analyzer functions
- Entering titles
- Executing commands
- Using softkeys

The following simple operations show you how to use these functions.

Performing Calculations

You can perform calculations while in any display allocation type except for ALL INSTRUMENT.

Let's try

1. Press the following key and softkeys:

   (Display) MORE DISPLAY ALLOCATION ALL BASIC

   The screen is cleared and a cursor appears at the bottom left of screen.

2. Type the following key from the keyboard:

   3*2 (Enter)

   The characters you enter are displayed at the current cursor position. After pressing (Enter), the system responds with the following answer at the bottom of screen:

   6

For more information, see "Numeric Computation" in the *HP Instrument BASIC Programming Techniques* of the *HP Instrument BASIC Users Handbook.*

Entering Arguments to the Active Analyzer Functions

The numeric keys on the keyboard can be used to input the arguments for an active analyzer function the same as using the front panel keys.

Let's try

1. Press the following key and softkeys:

   (Display) MORE DISPLAY ALLOCATION ALL INSTRUMENT

2. Then press the following key:

   (Start)

   The current start frequency is displayed on the screen and becomes the active analyzer function.

3. Type a value to change the frequency from the keyboard. For example, type this:

   100000

   The START value is cleared and the value you typed is displayed.

4. Then press the following key on the keyboard:

   (Enter)

   The START value is changed to 100 kHz.

5. Next, type the following value and key:

   2E6 (Enter)

   After pressing (Enter) the active function value is changed to 2 MHz. You can use the character "E" and "e" in an exponential expression.

Pressing (Backspace) on the keyboard deletes the last entry. This performs the same function as pressing (Back Space) on the front panel.

Entering Titles

The character entry keys can be used to enter a title on the screen instead of using front panel operation.

Let's Try

1. Press the following key and softkey:

   (Display) MORE TITLE

   A cursor appears at the top left of the graticule.

2. Type in characters using the keyboard, the characters you type appear at the top of the graticule.

3. Press the following key to terminate entry:

   (Enter)

You can enter standard uppercase and lowercase letters for the title, using the (Shift) key to access the alternate case as usual. For more information on the character entry keys, see "Character Entry Keys" in Appendix C.

Executing Commands

You can type in and execute commands from the keyboard at all times except when:

- The display allocation is ALL INSTRUMENT.
- A command is being executed.
- The analyzer is in the EDIT mode.

At all other times, you can type in commands and press (Enter) to present them to the system for execution. The system parses the command and takes the appropriate action.

Let's Try

1. Press the following key and softkey:

   (Display) MORE DISPLAY ALLOCATION HALF INSTR HALF BASIC

2. To check the current mass storage, type the following command:

   ```
   SYSTEM$("MSI") (Enter)
   ```

3. The system returns:

   ```
   :,4
   ```

Using Softkeys

Pressing f1 through f8 on the keyboard performs the same function as pressing a softkey on the front panel.

Entering BASIC Statements from the Front Panel Keys

The analyzer's HP Instrument BASIC allows you to enter and execute statements from the front panel keys (if the external mini-DIN keyboard is not connected).

Press the following key and softkeys from the front panel:

System IBASIC MORE [1/3] MORE [2/3] COMMAND ENTRY

The Command Entry menu is displayed on the softkey menu area, and the active entry area displays the letters, the digits 0 through 9, and some special characters including mathematical symbols. Three sets of letters can be scrolled using the step keys, ⇧ and ⇩. To enter a statement, press the step keys for the desired letter set, rotate the knob until the arrow "↑" points at the first letter, then press SELECT LETTER . Repeat this until the complete statement is entered, then press DONE to execute the statement.

3

Writing and Running Programs

This chapter describes how to write, execute (run), and list programs. The example program in this chapter also describes how to control the analyzer from an HP Instrument BASIC program. Topics covered in this chapter are:

- Getting into/out of the EDIT mode
- Writing programs
- Running (Executing) programs
- Listing programs

Getting into/out of the EDIT Mode

When you write a program, you must be in the EDIT mode. For more information about the EDIT mode, see Chapter 5.

Getting into the EDIT Mode

Press the following key and softkeys from the front panel:

(System) IBASIC Edit

The system enters the EDIT mode. You can also get into the EDIT mode from the keyboard. Type and press as follows:

EDIT and press (Enter)

Getting out of the EDIT Mode

Press the following softkey from the front panel:

END EDIT

The system exits the EDIT mode. If END EDIT does not appear on the softkey menu, press (System) IBASIC from the front panel, END EDIT will appear at the bottom of the menu.

You can also get out of the EDIT mode from the keyboard as follows:

Press (Shift) - (Alt) - (F4), (ESC), or (Home)

Writing Programs

Controlling the Analyzer

HP Instrument BASIC can control the analyzer (itself) through the "internal" HP-IB bus. This means that an analyzer with HP Instrument BASIC includes both a controller and an analyzer in the same instrument. They are connected through an internal HP-IB bus.

Note

The select code of the internal HP-IB interface is 8, and the HP-IB address of the analyzer can be any number from 0 to 30. In this manual, we use "800" for the device selector of the analyzer.

For more information on HP-IB addresses and device selectors, see "Device Selectors" in the *HP Instrument BASIC Interfacing Techniques* of the *HP Instrument BASIC Users Handbook* and "Available I/O Interfaces and Select Codes" in Chapter 9.

You can write the program by using the keyboard or by pressing keys and softkeys from the front panel procedure without using the external keyboard. Using the keyboard is very useful when you write a larger and more complex program, or type comments in a program. For detailed information on how to use the keyboard, see Appendix C.

Let's Try

The following example program selects the following measurement settings:

Active Channel Block	Channel 1 (default)
Measurement Block	Network Analyzer A/R LOG MAG format (default) Display scale to AUTO
Sweep Block	Center frequency: 70 MHz Span frequency: 100 kHz

1. Turn the analyzer ON.
2. Press the following key and softkeys to display the network analyzer mode softkeys:

   (Meas) `ANALYZER TYPE NETWORK ANALYZER RETURN`

3. Press the following key and softkeys from the front panel:

   (System) `IBASIC Edit`

   The system enters the EDIT mode. The cursor appears at line number 10, which is the default line number of the first program line, as follows:

```
10 _
```

4. Press the following softkey:

   `ASSIGN @Hp4396`

The commands are automatically entered at the current cursor position like this:

```
10 ASSIGN @Hp4396 TO 800_
```

5. Press the following key:

   (x1)

   The system reads the entire line.

```
10 ASSIGN @Hp4396 TO 800
20 _
```

6. Press the following softkey:

   OUTPUT @Hp4396

   The following characters are displayed on the screen:

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;""
```

7. Press the following key and softkey to preset the analyzer:

   (Preset)

   The HP-IB command to preset the analyzer ";PRES" is automatically entered at the current cursor position like this:

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;";PRES"
```

   Then press (x1).

Note

";" preceding the HP-IB command is automatically added, when you write the program by pressing keys. ";" is a separator to send more than one command in the same message.

8. Press the following key to select measurement parameter as A/R:

   OUTPUT @Hp4396 (Meas) ANALYZER TYPE NETWORK ANALYZER RETURN A/R

   The program code is automatically generated:

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;";PRES"
30 OUTPUT @Hp4396;";NA;MEAS AR"
```

Then enter [x1].

9. Press the following keys and softkeys to set the center frequency and frequency span:

   [System] IBASIC OUTPUT @Hp4396 [Center] 70[M/μ] [Span] 100 [k/m] [x1]

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;";PRES"
30 OUTPUT @Hp4396;";NA;MEAS AR"
40 OUTPUT @Hp4396;";CENT 70E6;SPAN 100E3"
50 _
```

10. Then press the following keys and softkeys to execute the auto scale function:

    [System] IBASIC OUTPUT @Hp4396 [Scale Ref] AUTO SCALE [x1]

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;";PRES"
30 OUTPUT @Hp4396;";NA;MEAS AR"
40 OUTPUT @Hp4396;";CENT 70E6;SPAN 100E3"
50 OUTPUT @Hp4396;";AUTO"
60 _
```

11. To terminate the program, the END command should be entered. Press the following softkey and key:

    [System] IBASIC END [x1]

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;";PRES"
30 OUTPUT @Hp4396;";NA;MEAS AR"
40 OUTPUT @Hp4396;";CENT 70E6;SPAN 100E3"
50 OUTPUT @Hp4396;";AUTO"
60 END
70 _
```

12. Press the following softkey to exit the EDIT mode:

    END EDIT

The screen returns to the analyzer display.

Running (Executing) Programs

Press the following key and softkeys from the front panel to execute the program:

(System) IBASIC Run

The system executes the program. You can execute the RUN statement from the keyboard. Type and press as follows:

RUN (Enter)

Listing Programs

The system can list the program on the screen and to a printer.

Listing on the Screen

You can list a program on the screen as follows:

Let's Try

1. Because the system lists a program in the print area, the Print Area must be allocated on the screen. For example:

   (Display) MORE DISPLAY ALLOCATE ALL BASIC

   All of the screen area is allocated for the print area.

2. Type as follows:

   LIST (Enter)

   The system lists the program as follows:

```
10 ASSIGN @Hp4396 TO 800
20 OUTPUT @Hp4396;";PRES"
30 OUTPUT @Hp4396;";NA;MEAS AR"
40 OUTPUT @Hp4396;";CENT 70E6;SPAN 100E3"
50 OUTPUT @Hp4396;";AUTO"
60 END
```

Listing to the Printer

Note For hard copy output, an parallel cable must connect the analyzer to the printer.

Let's Try

1. Set the output device to a printer as follows:

   `PRINTER IS PRT` Enter

2. Type and press as follows:

   `LIST` Enter

   The program is listed on the printer.

3. Set the output device to LCD as follows:

   `PRINTER IS LCD` Enter

If You Need More Information

This chapter is an introduction to using HP Instrument BASIC. For more information, see the following chapters and documents:

For more information on	See
EDIT mode	Chapter 5
Keyboard and softkeys	Appendix C
Display Allocation	"Display" in Appendix D
HP Instrument BASIC commands	*HP Instrument BASIC Language Reference* of the *HP Instrument BASIC Users Handbook*
HP-IB commands	*HP-IB Command Reference*

4

Saving and Getting Programs

This chapter describes how to save and get programs to or from the built-in flexible disk drive and RAM disk memory. Topics of this chapter are:

- Saving programs (SAVE)
- Listing file names (CAT)
- Getting programs (GET)

If you are using the disk drive for the first time, see "To Save and Recall" in Chapter 6 of the *Task Reference*.

Note HP Instrument BASIC on the analyzer cannot communicate with an external disk drive.

Note The analyzer can use either LIF (Logical Interchange Format) or DOS (Disk Operating System) formatted disks. The instrument automatically detects the disk format. It can use most of the same operations for either disk format.

Saving Programs (SAVE)

1. To use the built-in disk drive, insert a 2DD disk or 2HD disk into the disk drive.
2. If you are using a flexible disk for the first time, set the disk format to LIF or DOS and initialize the disk. See "To Save and Recall" in Chapter 6 of the *Task Reference* for the procedure.

Note When the analyzer is turned on, the RAM disk memory is automatically initialized by the format that is set by `FORMAT [ ]` under `FILE UTILITY` under (Save). If you want to change the disk format, initialize it. See "To Save and Recall" in Chapter 6 of the *Task Reference* for the procedure.

3. If the display allocation is ALL INSTRUMENT, change the allocation. For example:

   (Display) `MORE DISP ALLOCATION ALL BASIC`

4. Specify the system mass storage device as follows:

   When you want to use the built-in disk drive, type in `MSI ":INTERNAL,4"` or `MSI ":,4"`, then press (Enter).

   When you want to use the RAM disk memory, type in `MSI ":MEMORY,0"` or `MSI ":,0"`, then press (Enter).

5. Press the following key among the 3 menus which leads to the Shift - F9 key. And type in the filename to which you will store the program as follows:

   FILE UTILITY SAVE *file_name* (Enter)

   You can also save the file from the keyboard. Type and press as follows:

   SAVE *file_name* (Enter)

   The program is stored on the disk.

Note

If you get the error –257, "File name error", a file on the disk already has the name you are trying to use. In this case, you have three choices:

- Pick a new file name that doesn't already exist. To determine which file names are already being used, use the "CAT" command (see below).
- Replace an existing file, use the "RE-SAVE" statement.
- Purge the old file using the PURGE command, then save the new one.

Listing File Names (CAT)

Listing to Screen

Press the following key and softkeys:

1. If the display allocation is ALL INSTRUMENT or BASIC STATUS, change the allocation to either HALF INSTRument HALF BASIC or ALL BASIC. For example:

   (Display) MORE DISP ALLOCATION ALL BASIC

2. Press the following key among the 3 menus which leads to the Shift - F9 key:

   (Menu) (on the keyboard) FILE UTILITY CAT (Enter)

   You can list from the keyboard as follows:

   Type in CAT then press (Enter).

   The file names stored on the disk are listed on the screen.

Note

Because the CAT statement outputs 80 columns to a line and the maximum number of columns to a screen is 61, each line is wrapped at the 62th column. If you do not want the list to wrap around, execute the following statement before executing the CAT command.

```
PRINTER IS LCD;WIDTH 80
```

CAT will list the file names with no wrap around, but anything after the 62th column in the output cannot be seen.

Listing to Printer

Note For hard copy output, an parallel cable must connect the analyzer to the printer.

1. Set the output device to be a printer as follows:

   `PRINTER IS PRT` (Enter)

2. Press the following key among the 3 menus which leads to the `Shift - F9` key:

   `FILE UTILITY CAT` (Enter)

   You can list from the keyboard. Type and press as follows:

   `CAT` (Enter)

   The program is listed on the printer.

3. Get the output device back to LCD:

   `PRINTER IS LCD` (Enter)

Getting Programs (GET)

You can retrieve a program from the disk as follows:

1. If the display allocation is ALL INSTRUMENT, change the allocation to either HALF INSTRument HALF BASIC or ALL BASIC. For example:

   (Display) `MORE DISP ALLOCATION ALL BASIC`

2. Press the following key among the 3 menus which leads to the `Shift - F9` key and type the filename you want to retrieve:

   `FILE UTILITY GET` *file-name* (Enter)

   You can get the file from the keyboard. Type and press as follows:

   `GET` *file_name* (Enter)

If You Need More Information

This chapter is an introduction to saving and retrieving programs on a disk. For more information, see the following chapters and documents:

For more information on	See
IBASIC menu	"IBASIC Menu" in Appendix C.
Initializing a disk	"Save Menu" in Chapter 8 of the *Function Reference.*

5

Editing Programs

This chapter describes how to edit programs using the EDIT mode. The topics covered in this chapter are:

- Getting into/out of the EDIT mode
- Editing programs in the EDIT mode
- Renumbering program line numbers

Getting Into/Out of the EDIT Mode

Getting Into the EDIT Mode using the Front Panel Keys

Pressing the following key and softkey allows you to enter the EDIT mode immediately, irrespective of Display Allocation.

(System) IBASIC Edit

Entering the EDIT Mode from the Keyboard

Use the following keys to enter the EDIT mode with the cursor positioned at the specified line number. The *line_number* can be omitted. Press the following key among the 3 menus which leads to the Shift - F9 key.

EDIT *line_number* (Enter)
or type as follows:
EDIT *line_number* (Enter)

To use the keyboard, the Keyboard Input Line must be allocated on the screen. If it is not, press (Display) MORE DISPLAY ALLOCATION and select any allocation except ALL INSTRUMENT.

Getting Out of the EDIT Mode

The EDIT mode is exited by pressing (Shift) - (Alt) - (F4), (ESC), and (Home) from the keyboard (or by pressing the END EDIT softkey).

Editing Programs in the EDIT Mode

This section describes how to edit a program while in the EDIT mode, the topics are:

- Deleting characters
- Inserting characters
- Moving the cursor
- Scrolling lines and pages
- Jumping lines
- Inserting/deleting/recalling lines
- Clearing lines

See Appendix C for more information on functions of each key.

Deleting Characters

There are two functions you can use to delete characters: "Back space" and "Delete characters."

Back Space

Pressing (Back space) on the front panel (or on the keyboard) erases the character to the left of the cursor and moves the cursor left to the position of the erased character.

Deleting Characters

Pressing (Delete char) from the keyboard deletes the character at the cursor's position.

Inserting Characters

The EDIT mode is always in the insert mode. Characters you type at the keyboard are inserted before the current cursor position. (Pressing (Insert) performs no function.)

Moving the Cursor

The following key operations allow you to move the cursor horizontally along a line:

From the front panel	From the keyboard
Turning the knob	Pressing ◀ and ▶

Scrolling Lines and Pages

Scrolling Lines

The following key operations enable you to scroll lines up and down:

From the front panel	From the keyboard
Pressing ⇧ and ⇩	pressing ▲ and ▼

Scrolling Pages

Pressing (Page Up) and (Page Down) from the keyboard causes the display to scroll up and down in one page increments.

Jumping from the Current Line

Jumping to a Specified Line

You can specify a line by using a line number or a label name when jumping from the current line as follows:

`GOTO LINE` *line_number* (Enter)

or

`GOTO LINE` *label_name* (Enter)

If the label specified is not defined in the program, an error will occur.

Jumping to the Top/Bottom of a Program

Pressing the following keys allows you to jump to top or bottom of the program:

(Shift)-(▲)

(Shift)-(▼)

Inserting/Deleting/Recalling Lines

(Shift) - (Insert) inserts a new line above the current cursor position.

(Shift) - (Delete) deletes the line at which the cursor is.

`RECALL LINE` recalls the last deleted line.

Clearing Line

Pressing (Shift) - (End) clears a line from the current cursor position to the end of the line.

Renumbering Program Line Numbers

The `REN` command allows you to renumber the program currently in memory. You should execute the `REN` command after exiting the EDIT mode. Press the following key among the 3 menus which leads to the `Shift` - `F9` key.

`RENumber` (Enter)

or

`REN` (Enter)

You can specify the starting value, increment value, beginning line number, and the ending line number when renumbering a program as follows:

`RENumber` *starting_value*, *increment* `IN` *beginning_line_number*, *ending_line_number* (Enter)

or type as follows:

`REN` *starting_value*, *increment* `IN` *beginning_line_number*, *ending_line_number* (Enter)

line_label can be also use instead of *line_number*. For more information, see the *HP Instrument BASIC Language Reference* of the *HP Instrument BASIC Users Handbook.*

6

Application Programs

This chapter describes HP Instrument BASIC programming using examples. The examples correspond to actual measurement situations. These HP Instrument BASIC examples will supply useful information for developing the analyzer's HP Instrument BASIC application programs. The topics covered in this chapter are:

- Controlling the analyzer using HP Instrument BASIC
- I/O operation from HP Instrument BASIC
- Using HP Instrument BASIC with an external controller
- Sharing one printer between two controllers
- Loading HP Instrument BASIC programs using softkeys

Controlling the Analyzer Using HP Instrument BASIC

HP Instrument BASIC allows you to easily control the analyzer. This chapter describes the basic techniques for using HP Instrument BASIC to control the analyzer.

Note

Two quotes, in succession, will embed a quote within a string when a quotation mark needs to be in a string.

For example:

```
100 OUTPUT @Hp4396;";TITL ""This is a test."""
```

or

```
100 Title$="This is a test."
110 OUTPUT @Hp4396;";TITL """;Title$;""""
```

Sends string, `;TITL "This is a test."`, to the analyzer. (`TITL` displays a title.)

The analyzer and the HP Instrument BASIC in the analyzer should be regarded as two separate instruments interfaced by an internal HP-IB bus. So, to distinguish between the internal and external HP-IB interfaces, use select code "8" for the internal HP-IB interface (the external select code is "7"). For more information on HP-IB commands, see *HP-IB Command Reference* and the *HP-IB Programming Guide*. This program sends the HP-IB command by using the HP-IB interface from HP Instrument BASIC to the analyzer.

```
10 ASSIGN @Hp4396 TO 800  ! Assign HP-IB path to the analyzer
20 OUTPUT @Hp4396;";PRES" ! Preset the analyzer.
30 END
```

Figure 6-1. Sending HP-IB Command

Note For sample programs to control the analyzer, see the *HP-IB Programming Guide.*

I/O Operation from HP Instrument BASIC

This paragraph describes the input/output operations using the I/O port and the storage unit. The following programs are covered in this section:

- Data transfer using the I/O port
  - Reading data from the I/O port
  - Writing data to the I/O port
- Disk I/O for a storage unit
  - Saving trace data
  - Loading trace data

Data Transfer Using the I/O Port

The following two examples show input and output operations of the I/O port. The `READIO` and `WRITEIO` commands of HP Instrument BASIC directly control the I/O port and are faster than the `INP8IO?` and `OUTP8IO` HP-IB commands.

Reading Data from the I/O Port

This program shows how to directly read a specific data bit from the I/O port.

```
10 A=READIO(15,0)
20 PRINT A
30 END
```

Figure 6-2. Reading I/O Port

Writing Data to the I/O Port

This program shows an example of writing data to the I/O port. When you use the output port of the I/O port, the output data must be decimal data. Binary-expressed data is useful to set each bit ON or OFF. If you want to set bits of the output port using binary data, use the `IVAL` or `DVAL` command of HP Instrument BASIC. This command allows you to convert data from binary to decimal. The following example shows how to write binary data to the I/O port by using the `DVAL` command.

```
10 Bin_dat$="11111111"
20 Decimal_dat=DVAL(Bin_dat$,2) ! Convert binary data to decimal
30 WRITEIO 15,0;Decimal_dat
40 END
```

Figure 6-3. Writing Data to the I/O Port

Disk I/O for a Storage Unit

The analyzer has a built-in disk drive and RAM disk memory. You can save or get data using these disks with HP Instrument BASIC.

Saving Trace Data

This program saves the analyzer's current raw measurement data to an arbitrarily named file.

```
10 DIM File_name$[10]
20 ASSIGN @Hp4396 TO 800
30 INPUT "ENTER FILE NAME (up to 10 Characters)",File_name$
40 OUTPUT @Hp4396;"SAVDDAT """;File_name$;""""
50 END
```

Figure 6-4. Saving Trace data

Loading Trace Data

This program loads trace data from the built-in disk drive into the "Dat" array.

```
10 DIM Dat(1:201,1:2)
20 DIM File_name$[10]
30 ASSIGN @Hp4396 TO 800
40 MSI ":INTERNAL,4"
50 INPUT "ENTER FILE NAME (without EXT.)",File_name$
60 File_name$=File_name$&".DAT"
70 ASSIGN @File TO File_name$ ! Open target file
80 ENTER @File USING "16X,#"
90 ENTER @File USING "12X,#"
100 ENTER @File;Dat(*)        ! Load data from file
110 ASSIGN @File TO *         ! Close file
120 PRINT Dat(*)
130 END
```

Figure 6-5. Loading Trace Data

Line 40 selects the internal flexible disk drive. When you want to use the RAM disk memory, change ":INTERNAL,4" to ":MEMORY,0".

Line 60 adds an extension ".DAT" to file name for the DOS format file. When you want to use LIF format file, change ".DAT" to "_D".

Using HP Instrument BASIC with an External Controller

This program transfers a program from the HP Instrument BASIC memory to the external controller's disk through the HP-IB interface. This program must be executed on the external controller.

Note

For other topics listed below, see Chapter 7, "Controlling HP Instrument BASIC from Remote," of the *HP-IB Programming Guide.*

- Passing control between controllers
- Transferring a program to HP Instrument BASIC
- Running HP Instrument BASIC program from an external controller program
- Referring to an external controller's data array contents

```
10 DIM A$[10000]
20 ASSIGN @Hp4396 TO 717
30 OUTPUT @Hp4396;"*RST"
40 OUTPUT @Hp4396;":PROG:DEF?"
50 ENTER @Hp4396 USING "#,2A";Head$
60 B=VAL(Head$[2])
70 FOR I=1 TO B
80   ENTER @Hp4396 USING "%,A";Head$
90 NEXT I
100 ENTER @Hp4396 USING "-K";A$ ! Transfer the program
110 !
120 INPUT "File name?",File_name$
130 CREATE ASCII File_name$,1
140 ASSIGN @File TO File_name$
150 OUTPUT @File;A$
160 ASSIGN @File TO *
170 END
```

Figure 6-6.
Transferring the Program to an External Controller (on the External Controller)

Lines 50 to 90 read the file header: `#NMM ... M`.

The first byte is always "#".
`N` specifies the number of bytes that defines the program size.
`MM ... M` is program size in byte (`N` digits).

See `:PROGram[:SELected]:DEFine` in Chapter 2 of the *HP-IB Command Reference* for more information.

Note

The program to be uploaded must be in either the paused or stopped state.

Sharing One Printer Between Two Controllers

This program shows an example of sharing one printer between two controllers. The analyzer and the external controller use the printer in sequence. The external controller uses the printer first. The following is assumed:

- Two controllers and one printer on the same HP-IB bus
- Figure 6-7 is executed on the external controller
- Figure 6-8 is in the HP Instrument BASIC editor

```
10    Hp4396=717
20    Printer=PRT
30    !
40    OUTPUT Hp4396;":PROG:STAT RUN" ! Make HP Instrument BASIC run state
50    !
60    PRINTER IS Printer
70    PRINT "This line is printed out from ext. controller."
80    !
90    PASS CONTROL Hp4396
100   !
110   ON ERROR GOTO Not_active
120 Not_active:   ! Waiting until control is back
130   !
140   PRINT "This line is printed out from ext. controller again."
150   PRINTER IS LCD
160   END
```

Figure 6-7. Sharing a Printer (Program for External Controller)

```
10 ASSIGN @Hp4396 TO 800
20 Printer=PRT
30 !
40 PRINTER IS Printer
50 !
60 ON ERROR GOTO Not_active
70 Not_active:!
80 !
90 PRINT "This line is printed from IBASIC."
100 !
110 PASS CONTROL 721
120 PRINTER IS LCD
130 END
```

Figure 6-8. Sharing a Printer (Program for HP Instrument BASIC)

Loading HP Instrument BASIC Programs Using Softkeys

This program displays up to eight program file names in the analyzer's softkey label area. One of the programs can be selected and executed by just pressing a softkey. This feature lets you execute a program without using the keyboard. You only need to select the softkey of the program you want to execute.

You can name this program file, "AUTOST", so it will be executed automatically when the analyzer is turned ON.

When you want to recall this program again after the execution of an object file, you simply add the command `GET "AUTOST"` just before the `END` statement line of your object program code.

```
10 ASSIGN @Hp4396 TO 800
20 DIM Dir$(1:200)[80],File$(1:200)[10]
30 !
40 CAT TO Dir$(*)
50 !
60 File_number=0
70 REPEAT
80 File_number=File_number+1
90 File$(File_number)=Dir$(File_number+7)[1,10]
100 UNTIL File$(File_number)="" OR File_number>200
110 !
120 Max_page=INT((File_number-1)/6)+1
130 Npage=1
140 OUTPUT @Hp4396;"USKEY" ! SYSTEM key
150 OUTPUT @Hp4396;"KEY 0"  ! IBASIC key
160 OUTPUT @Hp4396;"KEY 6"  ! ON KEY LABEL key
170 Head: !
180 Page=(Npage-1)*6
190 ON KEY 1 LABEL File$(Page+1) GOSUB Jump1
200 ON KEY 2 LABEL File$(Page+2) GOSUB Jump2
210 ON KEY 3 LABEL File$(Page+3) GOSUB Jump3
220 ON KEY 4 LABEL File$(Page+4) GOSUB Jump4
230 ON KEY 5 LABEL File$(Page+5) GOSUB Jump5
240 ON KEY 6 LABEL File$(Page+6) GOSUB Jump6
250 ON KEY 7 LABEL "NEXT PAGE" GOTO Jump7
260 ON KEY 8 LABEL "PREV. PAGE" GOTO Jump8
270 !
280 LOOP
290 END LOOP
300 !
310 Jump1:GET File$(Page+1)
320 Jump2:GET File$(Page+2)
330 Jump3:GET File$(Page+3)
340 Jump4:GET File$(Page+4)
350 Jump5:GET File$(Page+5)
360 Jump6:GET File$(Page+6)
370 Jump7:IF Npage<Max_page THEN Npage=Npage+1
380 GOTO Head
390 Jump8:IF Npage>1 THEN Npage=Npage-1
400 GOTO Head
410 !
420 END
```

Figure 6-9. Loading HP Instrument BASIC Programs Using Softkeys

7

Program I/O

This chapter describes how to write programs that use the LCD, the I/O port, the external RUN/CONT connector in the analyzer, and the DOS file system.

Topics covered in this chapter are:

- Graphics
- Using the external RUN/CONT connector
- File system exceptions
- Using the I/O port in BASIC programs

Graphics

HP Instrument BASIC adds graphics capability to the analyzer. You can draw pictures on the LCD display independent of the grids and traces.

The analyzer has two screens, the instrument screen and the graphics screen. These two screens are always displayed together on the LCD and are not separately selectable. The instrument screen consists of a trace display area and a softkey label area. The HP Instrument BASIC editor is also displayed on the trace display area. The graphics screen covers the entire instrument screen as shown in Figure 7-1. The graphics screen is like an independent transparent overlay in front of the instrument screen. Therefore, you can draw figures in both the trace display and softkey label areas.

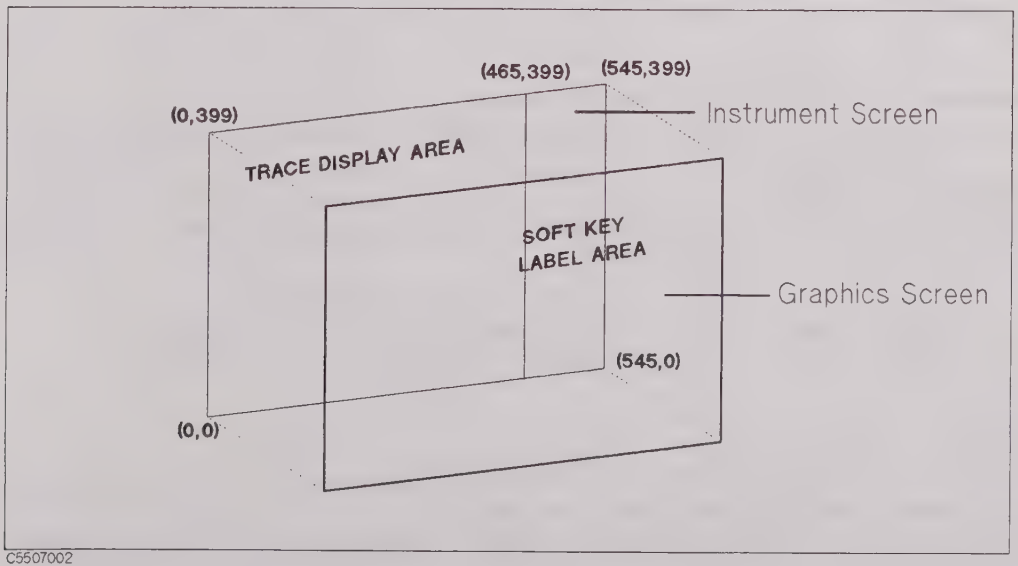


Figure 7-1. Screen Structure

Each point on the graphics screen is addressable using a coordinate address as shown in Figure 7-1. The bottom left corner is the origin (0,0) and the top right corner is the maximum horizontal and vertical end points (393,299). The MOVE and DRAW statement parameters are specified using these coordinate values. Because the aspect ratio of a graphics screen is 1, you need not adjust the aspect ratio when drawing figures.

HP Instrument BASIC Graphics Commands

The analyzer's HP Instrument BASIC has three graphics commands; MOVE, DRAW, and GCLEAR.

`MOVE`	Moves the pen from its current position to the specified coordinates.
`DRAW`	Draws a line from the current pen position to the specified coordinates.
`GCLEAR`	Clears the graphics screen, moves the pen from its current position to the origin (0,0), and selects pen 1.

Note The total times of executing the `MOVE` and `DRAW` commands is up to 1933, even if the pen position is not changed.

Hard Copies

Graphics hard copies can be obtained with the printing function.

PRINT

`PRINT` under Copy prints a display image on a printer. See "Copy Menu" in Chapter 8 of the *Function Reference*.

Initial settings

When power is turned ON, the default settings are as follows:

- MOVE 0,0

Example of Graphics Programming

This section describes an example of a simple program for drawing lines on the graphics screen.

- Drawing a Straight Line

  The following HP Instrument BASIC program will draw a line from coordinate (50,200) to coordinate (300,200) on the display.

```
GCLEAR                  ! INITIALIZE GRAPHICS MODE
MOVE 50,200             ! MOVE PEN TO COORDINATE  (50,200)
DRAW 300,200            ! DRAW A LINE TO COORDINATE (300,200)
END
```

- Drawing a Circle

  Trying to express all graphical images using only straight lines is tedious, slow, and difficult. This example describes a subprogram you can use to draw a circle. It can draw a circle by passing the center coordinates and the radius as arguments to the following subroutine. This subroutine can be used as a base for drawing arcs, setting different values for Theta, etc.

```
SUB Drawcircle(Centx,Centy,R)   !
```

```
  DEG                              ! USE DEGREES FOR ANGLE EXPRESSIONS
  X=Centx+R                        !
  Y=Centy                          !
  MOVE X,Y                         ! MOVE PEN TO INITIAL POINT
  For Theta=1 to 360               !
    X=INT(COS(Theta)*R+Centx)      ! NEXT X COORDINATE ON CIRCLE
    Y=INT(SIN(Theta)*R+Centy)      ! NEXT Y COORDINATE ON CIRCLE
    DRAW X,Y                       ! DRAW LINE TO NEXT POINT ON CIRCLE
  NEXT Theta                       ! UNTIL STARTING POINT IS REACHED
SUBEND                             !
```

Using the External RUN/CONT Connector

You can use the RUN or CONT commands in a program by inputting a TTL-compatible signal to the External RUN/CONT connector on the rear panel. At the negative-going edge of a pulse more than 20 μs wide (T_p) in the LOW state will trigger RUN or CONT.

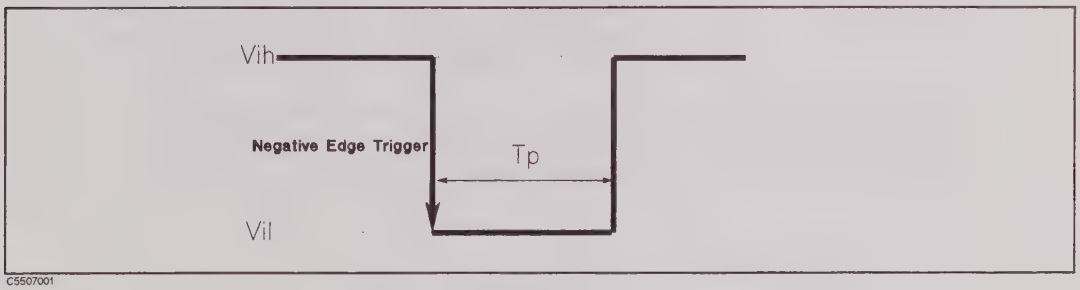


Figure 7-2. RUN/CONT Trigger Signal

File System Exceptions

The analyzer supports both the LIF and DOS file formats. When using an LIF format disk, the CREATE and CREATE DIR commands will generate an error.

Because the analyzer does not support an external disk drive, the MASS STORAGE IS (MSI) statement cannot specify volumes other than the built-in disk drive (volume specifier "INTERNAL,4", the default volume) and RAM disk memory (volume specifier "MEMORY,0").

Using the I/O Port in BASIC Programs

The HP Instrument BASIC can directly control the I/O port without using HP-IB commands. This is faster than using the `INP8IO?` and `OUTP8IO` HP-IB commands.

`READIO(15,0)`	Reads the 4-bit data from the I/O Port and returns a decimal value.
`WRITEIO 15,0;`*data*	Outputs the decimal value of the 8-bit data to the OUT 0 to 7 lines of the I/O port. The OUT 0 signal is the LSB (least significant bit), while the OUT 7 signal is the MSB (most significant bit).

See Appendix B for more information on `READIO` and `WRITEIO` commands.

For more information on the I/O port, see "I/O port" in Chapter 12 of the *Function Reference*.

8

Special Features and Advanced Techniques

The topics covered in this chapter are :

- Autoloading and running a program automatically (AUTOST)
- On Key Label function
- Increasing program speed

Autoloading and Running a Program Automatically (AUTOST)

The analyzer allows you to create a special program file called AUTOST. This program is automatically loaded and run every time the analyzer is turned ON.

When you use this capability, the disk on which you saved AUTOST must be inserted in the disk drive before the analyzer is turned ON.

The system first checks to see if there is an AUTOREC file on the disk. If there is, the system reads the AUTOREC file to set up the analyzer, and then loads and runs the AUTOST program. (For more information on AUTOREC, see "Auto Recall Function" in Appendix C of the *Function Reference.)*

On Key Label Function

The HP Instrument BASIC allows you to define softkeys from within a program. The softkey labels you define will appear when pressing the Shift - F10 key on the Keyboard. The labels are displayed while running the program.

The `ON KEY` statement is used to define the softkeys. For example:

```
.....
100 ON KEY 1 GOTO 150
110 ON KEY 2 LABEL "Print" GOSUB Report
.....
```

The `KEY` statement is used to display the softkey labels defined. The following set of statements is the same as the key strokes System `IBASIC ON KEY LABELS` :

```
.....
200 OUTPUT @Hp4396;"KEY 47"      ! SYSTEM key
210 OUTPUT @Hp4396;"KEY 0"       ! IBASIC softkey
220 OUTPUT @Hp4396;"KEY 7"       ! ON KEY LABELS softkey
.....
```

For more information on the ON KEY statement, see the *HP Instrument BASIC Language Reference* of the *HP Instrument BASIC Users Handbook.*

Example programs for ON KEY LABEL keys are shown in Chapter 6.

Increasing Program Speed

Because the analyzer's CPU interleaves processing measurements and executing a program, program execution speed depends on the measurement conditions. The display process also requires processing time.

To increase program speed (increase throughput), set the analyzer to the following conditions:

- If you do not need to measure the DUT when executing a program, set TRIGGER MODE to HOLD.
- If you need to measure the DUT but do not need to display the traces on the screen, set DISPLAY ALLOCATION to ALL BASIC.
- If you need to measure the DUT and display traces, but do not need to use the marker function, preset all markers.
- When you use the I/O port, use the `READIO` and `WRITEIO` commands to input or output data to the port directly.
- If you change channels in a program, set Dual Channel to ON before changing channels to avoid the setup time for the channel.

For example, when you change channels in a program, set Dual Channel to ON and Display Allocation to All BASIC to decrease the switching time between channels 1 and 2.

9

Analyzer Specific HP Instrument BASIC Features

This chapter lists and summarizes the HP Instrument BASIC features specific to the analyzer. Details of each feature are described in the previous chapters and in the appendixes.

This chapter covers the following topics:

- Available I/O interfaces and select codes
- Storage units
- HP-IB commands for HP Instrument BASIC

Available I/O Interfaces and Select Codes

Available interfaces and their select codes in the analyzer's HP Instrument BASIC are listed in the following table:

Select Codes	Devices
1	LCD
2	Keyboard
7	External HP-IB interface
8	Internal HP-IB interface

Note The analyzer does not have an RS-232C interface.

Storage Unit

The analyzer has two types of storage units: the built-in flexible disk drive and the RAM disk memory. Both the disk drive and RAM disk memory support the LIF and DOS formats.

To switch the system's storage units between the disk in the disk drive and the RAM disk under control of HP Instrument BASIC,

`MSI ":INTERNAL,4"` or `MSI ":,4"` for the built-in disk drive
`MSI ":MEMORY,0"` or `MSI ":,0"` for the RAM disk memory

Note

When you want to manage the storage units using the following HP-IB commands, use the `STODDISK` command (for the built-in disk drive) or the `STODMEMO` command (for the RAM disk memory) to specify the storage unit.

- CHAD
- CRED
- DISF
- INID
- PURG
- RECD
- RESAVD
- SAVDASC
- SAVDDAT
- SAVDGRA
- SAVDSTA

To copy a file between the disk and RAM disk, use an `FILC` command.

Note

The `FILC` command cannot be used to copy a file if the format (LIF or DOS) of the disk in the built-in disk drive is different from that of the RAM disk.

Use the front panel key or enter an HP-IB command to initialize the storage unit. (For the procedure for initialization using the front panel, see Chapter 6 of the *Task Reference*.) When using an HP-IB command to initialize the storage unit, execute the following procedure:

```
10  ASSIGN @Hp4396 TO 800
20  OUTPUT @Hp4396;"STODDISK"  ! Selects the built-in disk drive
30  OUTPUT @Hp4396;"DISF DOS"  ! Selects the DOS format
40  OUTPUT @Hp4396;"INID"      ! Initializes the disk
50  END
```

Built-in Flexible Disk Drive

The analyzer's HP Instrument BASIC has the following disk drive limitations:

- Disk types which can be initialized by the analyzer's HP Instrument BASIC `INITIALIZE` statement is 1.44 MByte (2HD). 720 Kbyte (2DD) and 270 Kbyte disks cannot be initialized.
- The only `INITIALIZE` format option is the default (256 byte/sector).
- DOS formats supported. The DOS formats supported are:

  720 Kbyte, 80 tracks, double-sided, 9 sectors/track
  1.44 Mbyte, 80 tracks, double-sided, 18 sectors/track
- HFS format is not supported.
- External disk drives are not supported.

RAM Disk Memory

A part of the RAM of the analyzer can be used as a virtual disk drive; RAM disk memory. RAM disk memory can be operated in the same way as the internal disk drive.

When the analyzer is turned OFF, the data saved in the RAM disk is lost, and the RAM disk memory is automatically initialized by the format that is set by `FORMAT [ ]` under `FILE UTILITIES` under (Save).

HP-IB Commands for HP Instrument BASIC

The PROGram subsystem commands of the analyzer's HP-IB commands are used to control HP Instrument BASIC. The PROGram subsystem commands do the following:

- Download the program from an external controller to the analyzer
- Upload the program from the analyzer to an external controller
- Delete the program on the BASIC editor of the analyzer
- Execute the program on the BASIC editor of the analyzer
- Set or query the variables and arrays in the program on the BASIC editor of the analyzer
- Set or query the state of the program on the BASIC editor of the analyzer

See the *HP-IB Command Reference* for more information and the *Programming Guide* for their usage example.

Note

The PROGram subsystem commands can be used from an external controller only.

A

Manual Changes

Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the analyzer than the current printing date of this manual. The information in this manual applies directly to the HP 4396B Network/Spectrum Analyzer serial number prefix listed on the title page of this manual.

Manual Changes

To adapt this manual to your HP 4396B, see Table A-1 and Table A-2, and make all the manual changes listed opposite your instrument's serial number and firmware version.

Instruments manufactured after the printing of this manual may be different from those documented in this manual. Later instrument versions will be documented in a manual changes supplement that will accompany the manual shipped with that instrument. If your instrument's serial number is not listed on the title page of this manual or in Table A-1, it may be documented in a *yellow MANUAL CHANGES* supplement.

In additions to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest *MANUAL CHANGES* supplement.

For information concerning serial number prefixes not listed on the title page or in the *MANUAL CHANGES* supplement, contact the nearest Hewlett-Packard office.

Turn on the line switch or execute the `*IDN?` command by HP-IB to confirm the firmware version. See the *HP-IB Command Reference* manual for information on the `*IDN?` command.

Table A-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes
JP1KE	

Table A-2. Manual Changes by Firmware Version

Version	Make Manual Changes

Instruments Covered by This Manual

Hewlett-Packard uses a two-part, nine-character serial number that is stamped on the serial number plate (see Figure A-1) attached to the rear panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix.

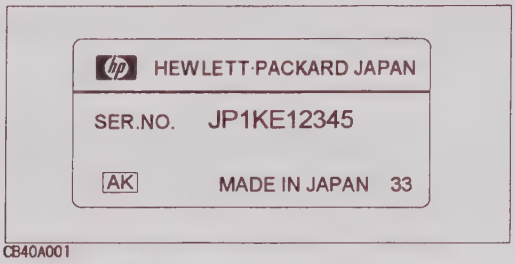


Figure A-1. Serial Number Plate

BASIC Commands Specific to HP 4396B

BASIC Commands Not Implemented

The following commands are listed in the *HP Instrument BASIC Language Reference* of the *HP Instrument Users Handbook*, but are not implemented in the analyzer's HP Instrument BASIC.

- OFF CYCLE
- ON CYCLE

Note

GCLEAR and ON TIMEOUT commands are available, but the following supplementary items are added.

- GCLEAR

  Moves the pen to (0,0).

- OFF TIMEOUT and ON TIMEOUT

  The interface select code is 7 only.

BASIC Commands Specific to HP 4396B

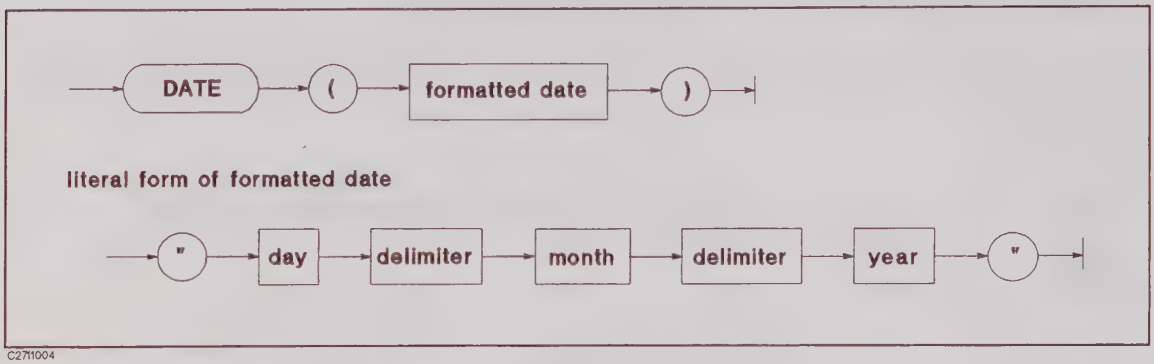
The following commands are *not* listed in the *HP Instrument BASIC Language Reference* of the *HP Instrument BASIC Users Handbook*, but are available in the analyzer's HP Instrument BASIC.

- DATE
- DATE$
- EXECUTE
- READIO
- SET TIME
- SET TIMEDATE
- TIME
- TIME$
- WRITEIO

DATE

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command converts data formatted as (DD MMM YYY) into the numeric value used to set the clock.



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Item	Description	Range
formatted date	string expression	(see drawing and text)
day	integer constant	1 to end-of-month
month	Literal (letter case ignored)	JAN, FEB, MAR, APR, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC
year	integer constant	1900 to 2079

- Example Commands

```
PRINT DATE("21 MAY 1991")
SET TIMEDATE DATE("1 Jan 1991")
Days=(DATE("1 JAN 1991")-DATE("11 NOV 1990")) DIV 86400
```

- Semantics

  Using a value from the DATE command as the argument for SET TIMEDATE will set the clock to midnight on the date specified. The results from the DATE and TIME commands must be combined to set the date and time of day.

  If the DATE command is used as an argument for SET TIMEDATE to set the clock, the date must be in the range: 1 Mar 1900 to 4 Aug 2079.

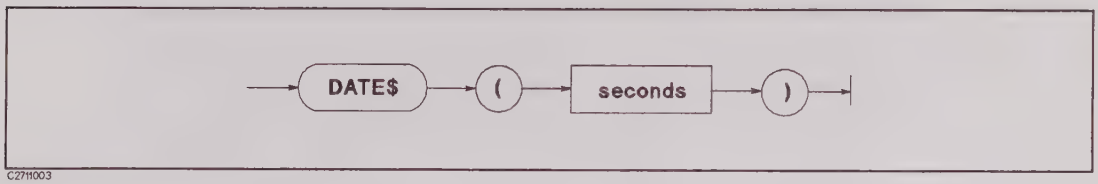
  Specifying an invalid date, such as the thirty-first of February, will cause an error.

  Leading blanks or non-numeric characters are ignored. ASCII spaces are recommended as delimiters between the day, month, and year. However, any non-alphanumeric character except the negative sign (–), may be used as the delimiter.

DATE$

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command formats the number of seconds into a date (DD MMM YYY).



Item	Description	Range
seconds	numeric expression	−4.623683256E+12 to 4.6534263350399E+13

- Example Commands

```
PRINT DATE$(TIMEDATE)
DISP DATE$(2.111510608E+11)
```

- Semantics

  The date returned is in the form: DD MMM YYYY, where DD is the day of the month, MMM is the month, and YYYY is the year.

  The day is a blank filled to two character positions. Single ASCII spaces delimit the day, month, and year.

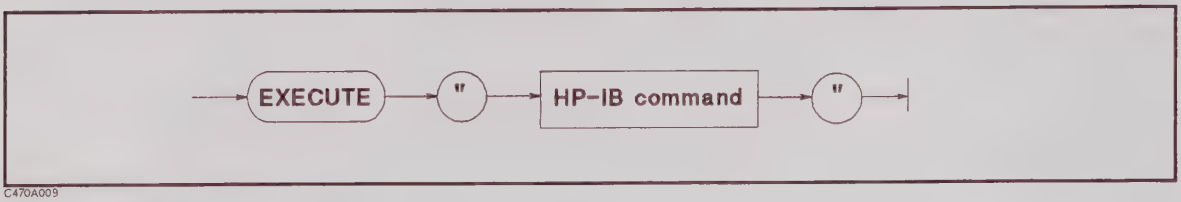
  The first letter of the month is capitalized and the rest are lowercase charters.

  Years less than the year 0 are expressed as negative years.

EXECUTE

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command executes specific HP-IB commands faster than the OUTPUT statement.



C470A009

Item	Description	Range
HP-IB command	string expression	refer to Table B-1

Table B-1. HP-IB Commands for EXECUTE

ANAOCH1	NUMLMAX?	PEAN?
ANAOCH2	NUMLMIN?	POLE?
ANAODATA	OUTPMAX?	RPLENV?
ANAOMEMO	OUTPMEAN?	RPLHEI?
ANARANG	OUTPMIN?	RPLLHEI?
ANARFULL	OUTPMINMAX?	RPLMEA?
EQUCPARA?	OUTPCERR?	RPLPP?
EQUCPARS?	OUTPCFIL?	RPLRHEI?
EQUCPARS4?	OUTPFILT?	RPLVAL?
EQUCO?	OUTPRESF?	SING
EQUM	OUTPRESO?	TARL?
LMAX?	OUTPRESR?	TARR?
LMIN?	OUTPXFIL?	THRR
NEXPK?	PEAK?	

- Example Commands

```
EXECUTE "SING"
EXECUTE "ANAOCH1"
```

- Semantics
  - Handling HP-IB command parameters and a query command's return value when an HP-IB command is executed by the `execute` command:

    To transfer HP-IB command parameters, use a `WRITEIO` command. This command must be executed before the `EXECUTE` command. One `WRITEIO` command is required to transfer one parameter. For example, to transfer two `ANARANGE` command parameters to the EXECUTE command, write the program as follows:

```
WRITEIO 8,0; 100E6
WRITEIO 8,1: 200E6
EXECUTE "ANARANG"
```

    To receive a query command's return value, use a `READIO` function. The `READIO` function returns only one specified return value. For example, four return values (`Za`, `Fa`, `Zr`, and `Fr`) of the query command `OUTPRESO?` must be received by writing the program as follows:

```
EXECUTE "OUTPRESO?"
Za=READIO(8,0)
Fa=READIO(8,1)
Zr=READIO(8,2)
Fr=READIO(8,3)
```

  - HP-IB Commands that work differently when executed by the `EXECUTE` command:

    When the following HP-IB command is executed by the `EXECUTE` command, it works differently than when it is executed by the `OUTPUT` command.

`SING`	The HP 4396B executes `EXECUTE "SING"` to sweep once. Execution of the next statement is suppressed until the sweep is completed. Therefore, the completion of the sweep need not be supervised using a status register.

Note

When both an external controller and HP instrument BASIC are used at the same time, the EXECUTE command occasionally does not terminate normally. If the external controller queries the instrument while the HP 4396B is sweeping when triggered by EXECUTE "SING", the EXECUTE command does not terminate normally (In the worst case, a system halt occurs).

To avoid this problem, it is necessary to use an SRQ interrupt technique that uses the status register. In this case, the external controller waits to send query commands until HP Instrument BASIC completes the execution of the EXECUTE command.

- For External Controller

```
 10  REAL Meas(1)
 20  ASSIGN @Hp4396 TO 717
 30  OUTPUT @Hp4396;"*CLS; *OPC?"
 40  ENTER @Hp4396;Opc
 50  OUTPUT @Hp4396;"OSPT 0"
 60  ON INTR 7 GOTO Anaend
 70  OUTPUT @Hp4396;"PROG:STAT RUN"
 80  !
 90 Start:!
100  OUTPUT @Hp4396;"*CLS; *OPC?"
110  ENTER @Hp4396;Opc
120  ENABLE INTR 7;2
130 Waiting: GOTO Waiting
140 Anaend:!
150  OUTPUT @Hp4396;"PROG:NUMB? MEAS"
160  ENTER @Hp4396;Meas(*)
170  PRINT Meas(*)
180  OUTPUT @Hp4396;"*CLS; *OPC?"
190  OUTPUT @Hp4396;"PROG:STAT CONT"
200  GOTO Start
210  END
```

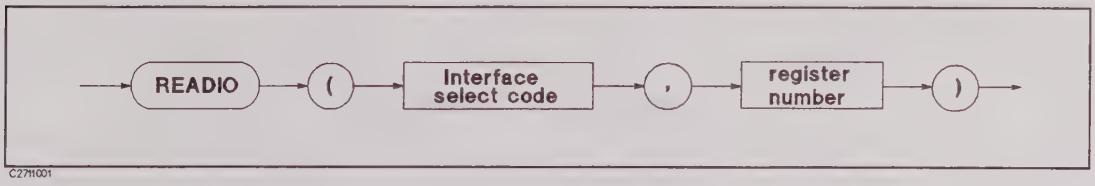
- For HP Instrument BASIC

```
 10 REAL Meas(1)
 20 ASSIGN @Hp4396 TO 800
 30 OUTPUT @Hp4396;"OSE 16384;OSNT 16384;*SRE 128"
 40 !
 50 LOOP
 60  EXECUTE "ANAOCH1;ANAODATA;ANARFULL"
 70  EXECUTE "SING"
 80  EXECUTE "OUTPMAX?"
 90  Meas(0) = READIO(8,0)
100  Meas(1) = READIO(8,1)
110  PAUSE
120 END LOOP
```

READIO

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command reads the contents of the register used for an I/O port or EXECUTE command.



Item	Description	Range
select code	numeric expression	8: EXECUTE register 15: I/O port
register number	numeric expression	0 to 800 (Select code 8) 0: I/O port

- Example Commands

```
Ioport=READIO(15,0)

100  EXECUTE "OUTPRESO?"
110  Za=READIO(8,0)
120  Fa=READIO(8,1)
130  Zr=READIO(8,2)
140  Fr=READIO(8,3)
```

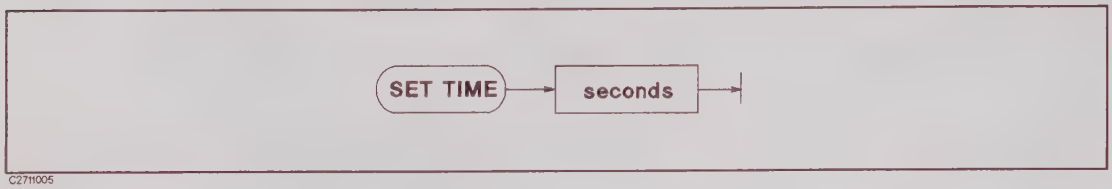
- Semantics

The EXECUTE command stores the query command's return values in registers. The READIO command reads a return value from one of these registers. Return values are sequentially stored in registers 0 to 3. For example, when EXECUTE"OUTPURESO?" is executed, four return values Za, Fa, Zr, and Fr are stored in four registers, register 0 to register 3. Za is stored in register 0, Fa in register 1, Zr in register 2, and Fr in register 3. To read a return value stored by the READIO command, specify the appropriate register number. For more information on EXECUTE command, see the example in the "EXECUTE" command.

SET TIME

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command resets the time-of-day given by the real-time clock.



Item	Description	Range
seconds	numeric expression, rounded to the nearest hundredth	0 to 86399.99

- Example Commands

```
SET TIME 0
SET TIME Hours*3600+Minutes*60
```

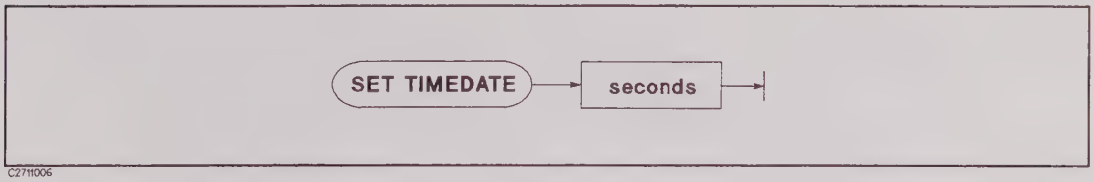
- Semantics

  This command changes only the time within the current day, not the date. The new clock setting is equivalent to (TIMEDATE DIV 86400)×86400 plus the specified setting.

SET TIMEDATE

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command resets the absolute seconds (time and day) given by the real-time clock.



Item	Description	Range
seconds	numeric expression, rounded to the nearest hundredth	2.08662912E+12 to 2.143252224E+11

- Example Commands

```
SET TIMEDATE TIMEDATE+86400
SET TIMEDATE Strange_number
```

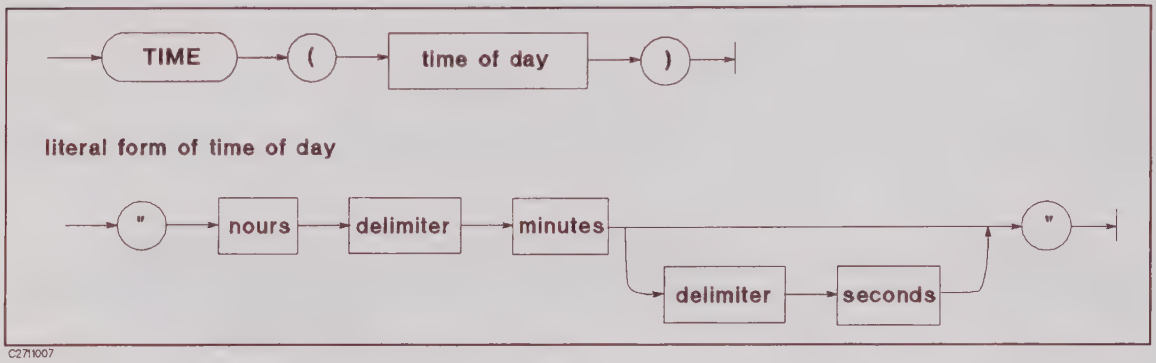
- Semantics

  The volatile clock is set to 2.08662912E+11 (midnight March 1, 1900) at power-on. If there is a battery-backed (non-volatile) clock, then the volatile clock is set to its value at power-up. If the computer is linked to an SRM system (and has no battery-backed clock), then the volatile clock is set to the SRM clock value when the SRM and DCOMM binaries are loaded. The clock values represent Julian time, expressed in seconds.

TIME

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command converts data formatted as time of day (HH:MM:SS), into the number of seconds past midnight.



Item	Description	Range
time of day	string expression representing the time in 24 hour format	(set drawing)
hours	literal	0 to 23
minutes	literal	0 to 59
seconds	literal; default = 0	0 to 59.99
delimiter	literal; single character	(see text)

- Example Commands

```
Seconds=TIME(T$)
SET TIME TIME("8:37:20")
ON TIME TIME("12:10") GOSUB Lunch
```

- Semantics

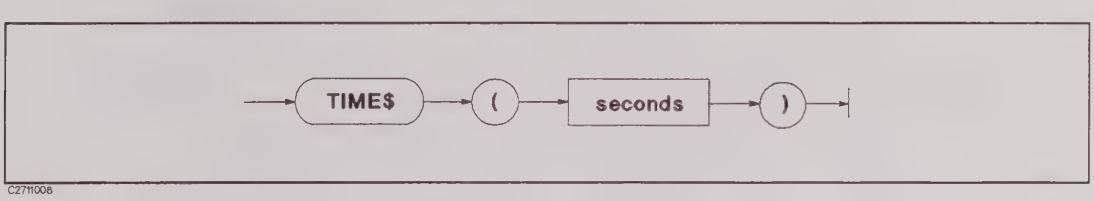
  This command returns a positive integer, in the range 0 to 86399, equivalent to the number of seconds past midnight.

  While any number of non-numeric characters may be used as a delimiter, a single colon is recommended. Leading blanks and non-numeric characters are ignored.

TIME$

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This command converts the number of seconds past midnight into a string representing the time of day (HH:MM:SS).



Item	Description	Range
seconds	numeric expression, truncated to the nearest second; seconds past midnight	0 to 86399

- Example Commands

```
DISP "The time is:  ";TIME$(TIMEDATE)
PRINT TIME$(45296)
```

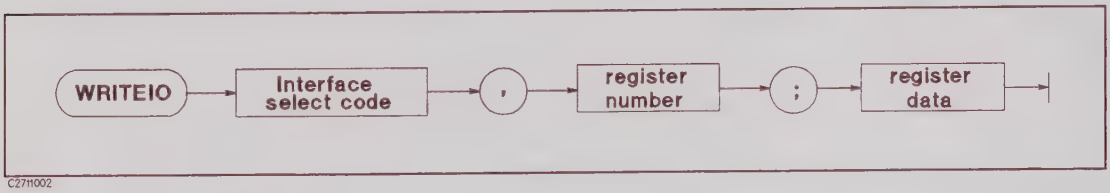
- Semantics

  TIME$ takes the time in seconds and returns the time of day in the form HH:MM:SS, where HH represents hours, MM represents minutes, and SS represents seconds. A module 86400 is performed on the parameter before it is formatted as a time of day.

WRITEIO

Keyboard Executable	Yes
Programmable	Yes
In an IF ... THEN ...	Yes

This statement writes register data in decimal notation to a specified EXECUTE command parameter register or to a specified I/O port.



Item	Description	Range
select code	numeric expression	8: EXECUTE register 15: I/O port
register number	numeric expression	0 to 800 (Select code 8) 0: I/O port
register data	numeric expression	−2147483648 to +2147483647 0 to 255: I/O port

- Example Commands

```
WRITEIO 15,0;12

100  WRITEIO 8,0; 100E6
110  WRITEIO 8,1; 200E6
120  EXECUTE "ANARANG"
```

- Semantics
  - How to write data to the I/O port:

    When writing data to an I/O port, use `15,0` as the select code and the register number that corresponds with the register. The range of register data for the I/O port is 0 through 255.

  - How to write HP-IB command parameters when the `EXECUTE` command is used:

    The `EXECUTE` command uses the data stored in a register (select code 8) as a parameter. To store this parameter, the `WRITEIO` command must be executed before the `EXECUTE` command. The `WRITEIO` command stores one parameter in one register like the `READIO` command. For an HP-IB command that requires multiple parameters, use as many `WRITEIO` commands as the number of parameters. For more information on the `EXECUTE` command, see the "EXECUTE" command.

The Keyboard

Character Entry Keys

The character entry keys are arranged in the familiar QWERTY typewriter layout, but with additional features.

[Caps] Sets the unshifted keyboard to either upper-case (which is the default after power ON) or lower-case (normal typewriter operation).

[Shift] You can enter standard upper-case and lower-case letters, using the [Shift] key to access the alternate case.

[Enter] Has three functions:

- When a running program prompts you for data, respond by typing in the requested data and then press [Enter]. This signals the program that you have provided the data and that it can resume execution.
- When typing in program source code, the [Enter] key is used to store each line of program code.
- After typing in a command, the [Enter] key causes the command to be executed.

[CTRL] In the EDIT mode, [CTRL] allows you to control the editor in the same as using the cursor-control, display-control, and editing keys. For more detail, see "Using [CTRL] Key in Edit Mode".

[Backspace] Erases the character to the left of the cursor and moves the cursor to the erased character's position on the line.

[Tab] Performs no function.

Cursor-Control and Display-Control Keys

[▲] [▼] Allow you to scroll lines up and down in the print display area. Shifted, these keys cause the display to scroll toward the top or bottom of the display.

[▶] [◀] Allow you to move horizontally along a line. Shifted, these keys allow you to "jump" to the left and right limits of the current line.

[Page Up] [Page Down] Cause the display to scroll up or down in one page increments.

[Home] Performs no function.

Numeric Keypad

The numerical keypad provides a convenient way to enter numbers and perform arithmetic operations. Just type in the arithmetic expression you want to evaluate, then press [Enter]. The result is displayed in the lower-left corner of the screen.

[Enter]	Performs the same function as the [Enter] key. The numerical keypad serves the same function as the numerical keypad on the front panel of the analyzer.
[Num Lock]	Performs no function. Pressing the [Num Lock] key causes the LED ON/OFF, but the keys are performes as the numerical keypad only.

Editing Keys

[Insert]	Performs no function. The HP Instrument BASIC is always in the insert mode. The characters you type are always inserted to the left of the cursor.
[Shift] - [Insert]	Inserts a new line above the cursor's current position (edit mode only).
[Delete]	Deletes the character at the cursor's position.
[Shift] - [Delete]	Deletes the line containing the cursor (edit mode only).
[End]	Delete the line containing the cursor except the line number.
[Shift] - [End]	Clears from the current cursor position to the end of the line.
[Home]	Clears the entire alpha screen. In EDIT mode, this exits the EDIT mode.

Program Control Keys

The following keys allow you to control execution of the program stored in the analyzer's memory.

[Pause]	[Pause] or [Alt] - [F4] pauses program execution after the current line. Pressing `Continue` in the System menu resumes program execution from the point where it paused. [Shift] - [Alt] - [F4] stops program execution after the current line. To restart the program, press `Run` in the System menu. When in the editor mode, [Shift] - [Alt] - [F4] exits the edit mode.
[Ctrl] - [Break]	[Ctrl] - [Break] resets program execution immediately without erasing the program from memory (**BASIC RESET**). Pauses program execution when the computer is performing or trying to perform an I/O operation. Press [Alt] - [F5] instead of [Pause] or [Alt] - [F4] when the computer is hung up during an I/O operation, because [Pause] or [Alt] - [F4] works only after the computer finishes the current program line.

System Control Keys

Shift - Page Up (Recall)	Shift - Page Up (Recall) recalls the last line the you entered, executed, or deleted. Several previous lines can be recalled this way. Recall is particularly handy to use when you mistype a line. Instead of retyping the entire line, you can recall it, edit it using the editing keys, and enter or execute it again. Shift-Page Down moves forward through the recall stack.
Alt - F3 (Run)	Starts a program running from the beginning.
Alt - F2 (Continue)	Resumes program execution from the point where it paused.
F12 (IBASIC)	Allows you to type BASIC commands on Keyboard Input Line. If Display Allocation is ALL INSTRUMENT, pressing this key changes the Display Allocation to BASIC STATUS. Shift-F12 changes Display Allocation to ALL INSTRUMENT.

Softkeys and Softkey Control

There are eight softkeys (labeled f1 through f8). The softkey labels are indicated on the right of the analyzer's screen.

Softkey Control Keys

Pressing the following:

F9	Leads to the IBASIC menu, which controls programs and the editor.
Shift - F9	leads to the BASIC menu from which to control a BASIC program. This menu is the same menu displayed when pressing SYSTEM IBASIC from the front panel. In the edit mode, pressing F10 leads to the Edit System menu, which provides softkeys to conveniently enter BASIC commands. Shift - F10 (User) leads to the ON KEY LABEL menu, which are user defined softkeys in a BASIC program. (For information on getting to this menu through the HP Instrument BASIC, see "On Key Label Function" in Chapter 8.)

Softkeys

F9 and F10 keys leads to the IBASIC menu. Pressing a softkey performs the command labeled or produces a sequence of characters on the keyboard input line (or on the "current line" in the EDIT mode).

Pressing the softkeys on the front panel of the analyzer performs the same functions as pressing the f1 through f8 function keys.

Softkeys Accessed from Shift - F9 Key

IBASIC Menu

Pressing the following:

Step	Produces the command "Step" on the keyboard input line. Step executes a program at every line.
Continue	Produces the command "Continue" on the keyboard input line. Resumes program execution from the point where it paused.
Run	Produces the command "Run" on the keyboard input line. Immediately executes a program.
Pause	Produces the command "Pause" on the keyboard input line. Pauses program execution after the current program line is executed.
Stop	Produces the command "Stop" on the keyboard input line. Stops program execution after the current line. To restart the program, press Run.
EDIT	Produces the command "EDIT" on the keyboard input line. After EDIT is entered, pressing Enter enters the edit mode.
ON KEY LABELS	Leads to a softkey menu defined during program execution, if the softkey menu has been defined.
CAT	Produces the command "CAT". CAT lists the contents of a mass storage directory.
SAVE	Produces the command "SAVE". SAVE creates an ASCII file and copies program lines as strings into that file.
RE-SAVE	Produces the command "RE-SAVE". RE-SAVE creates a specified ASCII file if it does not exist; otherwise, it rewrites a specified ASCII file by copying program lines as strings into that file.
GET	Produces the command "GET". GET reads the specified ASCII file and attempts to store the strings into memory as program lines.
PURGE	Produces the command "PURGE". PURGE deletes a file or directory from the directory of a mass storage media.
INITIALIZE	Produces the command "INITIALIZE". INITIALIZE prepares mass storage media for use by the computer. When INITIALIZE is executed, any data on the media is lost.
MSI []	Produces the command "MSI []" on the keyboard input line. MSI [] specifies the mass strage. INTERNAL specifies the internal flexible disk, MEMORY specifies the RAM disk.
SCRATCH	Produces the command "SCRATCH". The SCRATCH erases the program in memory. After SCRATCH is entered, pressing Enter executes the command.
RENumber	Produces the command "REN". REN renumbers all of the program lines currently in memory.
LIST	Produces the command "LIST". Lists the program on the screen.
COMMAND ENTRY	Leads to the Command entry menu, which allows you to execute the HP Instrument BASIC commands from the front panel keys.
CLEAR I/O	Produces the command "CLEAR I/O". Pauses I/O operation program. To restart the program, press Continue.

RESET	Produces the command "RESET". Aborts the program.

Softkeys Accessed form (F10) Key

(F10) key allows you to access three different softkey flows dependent on conditions as follows:

- Pressing (F10) accesses the Program Control menu
- In editor mode, pressing (F10) accesses the Edit System menu
- Pressing (Shift)-(F10) accesses the On Key Label menu.

The menus listed above are described in "Instrument BASIC Menu" in Chapter 8 of the *Function Reference*.

Using (CTRL) Key in Edit Mode

In the edit mode, pressing (CTRL), holding it down and pressing another key, allows you to control the editor in the same way as pressing control keys such as (▲), (▼), (Insert line), etc.

If you press ...	It performs ...
(CTRL)-(a)	Moves the cursor to beginning of line, (the same function as (Shift)-(◀)).
(CTRL)-(b)	Moves cursor backward one character, (the same function as (◀)).
(CTRL)-(d)	Deletes a character, (the same function as (Delete)).
(CTRL)-(e)	Moves the cursor to end of the line, (the same function as (Shift)-(▶)).
(CTRL)-(f)	Moves cursor forward character along a line, (the same function as (▶)).
(CTRL)-(g)	Allows you to move the cursor to any line number or label, after press (CTRL)-(g), type a line number or label name and press (Enter), the cursor moves to the specified line, (the same function as `GOTO LINE`).
(CTRL)-(h)	Deletes backward one character, (the same function as (Back Space)).
(CTRL)-(j)	Performs the same function as (Enter).
(CTRL)-(k)	Deletes a line from the cursor's current position to the end of the line.
(CTRL)-(m)	Performs the same function as (Enter).
(CTRL)-(n)	Moves the cursor to the next line, (the same function as (▼)).
(CTRL)-(o)	Inserts a new line above the cursor's current position, (the same function as (Shift) - (Insert)).
(CTRL)-(p)	Moves the cursor to the previous line, (the same function as (▲)).

D

Softkeys Used for HP Instrument BASIC Operation

The following softkeys are available with the HP Instrument BASIC:

(System) `IBASIC` controls HP Instrument BASIC.

`MEMORY PARTITION` changes size of memory areas for HP Instrument BASIC and the RAM disk.

(Display) `DISPLAY ALLOCATION` allocates the BASIC screen area on the display.

System

IBASIC

Displays the following softkeys to control HP Instrument BASIC (IBASIC):

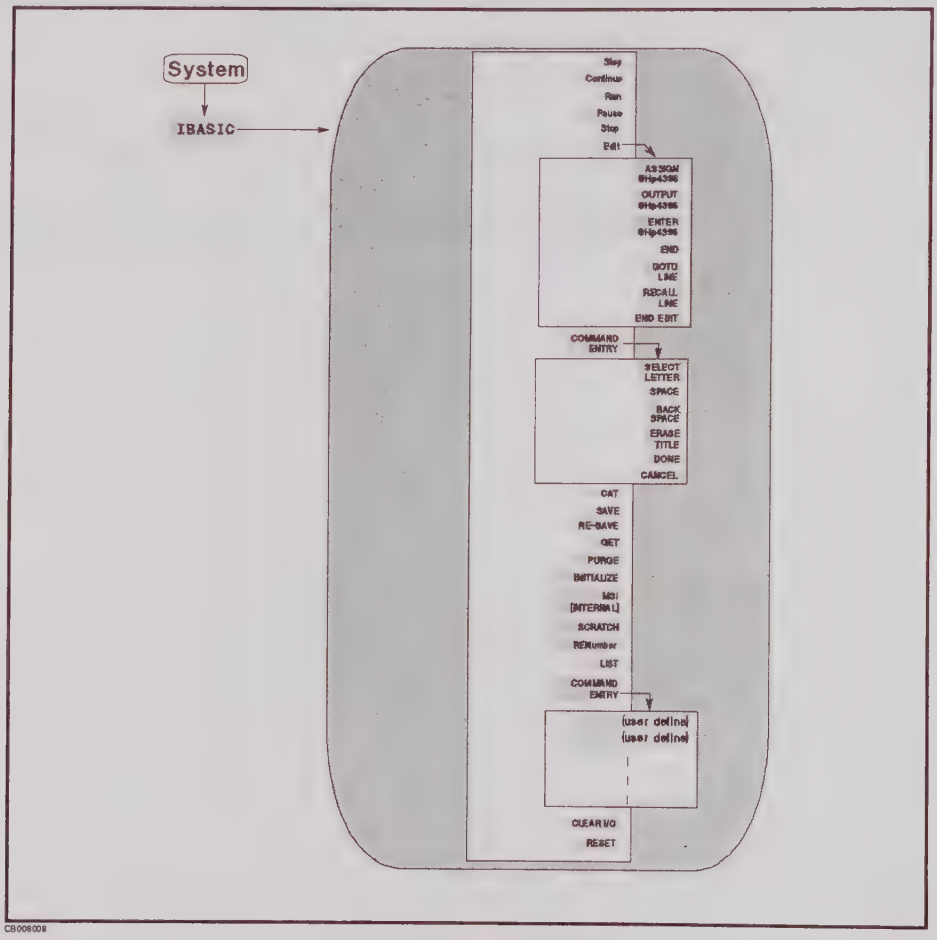


Figure D-1. IBASIC Menu

Step	Allows you to execute one program line at a time. This is particularly useful for debugging.
Continue	Resumes program execution from the point where it paused.
Run	Starts a program from its beginning.
Pause	Pauses program execution after the current program line is executed.
Stop	Stops program execution after the current line. To restart the program, press Run.
Edit	Enters into the EDIT mode.

ASSIGN @Hp4396	Produces the command "ASSIGN @Hp4396 TO 800" at the cursor's current position.
OUTPUT @Hp4396	Produces the command "OUTPUT @Hp4396;"" " at the cursor's current position.
ENTER @Hp4396	Produces the command "ENTER @Hp4396;" at the cursor's current position.
END	Produces the command "END".
GOTO LINE	Allows you to move the cursor to any line number or to a label. After pressing GOTO LINE, type a line number or a label and then press (Return). The cursor moves to the specified line or label.
RECALL LINE	Recalls the last deleted line.
END EDIT	Exits the edit mode.
ON KEY LABELS	Leads to a softkey menu defined during program execution, if the softkey menu has been defined.
CAT	Produces the command "CAT". CAT lists the contents of a mass storage directory.
SAVE	Produces the command "SAVE". SAVE creates an ASCII file and copies program lines as strings into that file.
RE-SAVE	Produces the command "RE-SAVE". RE-SAVE creates a specified ASCII file if it does not exist; otherwise, it rewrites a specified ASCII file by copying program lines as strings into that file.
GET	Produces the command "GET". GET reads the specified ASCII file and attempts to store the strings into memory as program lines.
PURGE	Produces the command "PURGE". PURGE deletes a file or directory from the directory of a mass storage media.
INITIALIZE	Produces the command "INITIALIZE". INITIALIZE prepares mass storage media for use by the computer. When INITIALIZE is executed, any data on the media is lost.
MSI []	Produces the command "MSI []" on the keyboard input line. MSI [] specifies the mass strage. INTERNAL specifies the internal flexible disk, MEMORY specifies the RAM disk.
SCRATCH	Produces the command "SCRATCH". The SCRATCH erases the program in memory. After SCRATCH is entered, pressing (Enter) executes the command.
RENumber	Produces the command "REN". REN renumbers all of the program lines currently in memory.
LIST	Produces the command "LIST". Lists the program on the screen.
COMMAND ENTRY	Leads to the Command entry menu, which allows you to execute the HP Instrument BASIC commands from the front panel keys.
SELECT LETTER	Selects the character pointed to by "↑".
SPACE	Inserts a space.
BACK SPACE	Deletes the last character entered.
ERASE TITLE	Deletes all characters entered.
DONE	Terminates command entry, and executes the command you entered.

`CANCEL`	Cancels command entry and returns to the BASIC menu.
`CLEAR I/O`	Produces the command "`CLEAR I/O`". Pauses I/O operation program. To restart the program, press `Continue`.
`RESET`	Produces the command "`RESET`". Aborts the program.

MEMORY PARTITION

Changes size of memory areas for HP Instrument BASIC and the RAM disk memory.

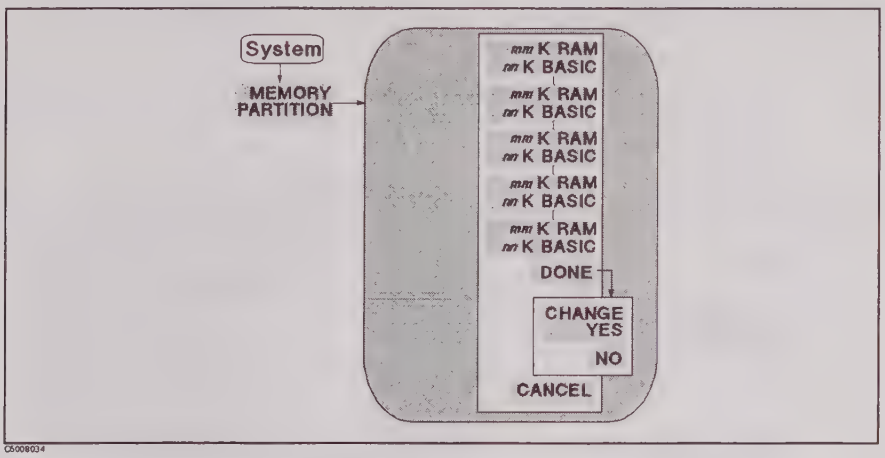


Figure D-2. Memory Partition Menu

`mm K RAM nn K BASIC`	Selects memory partition so that *mm* Kbyte is for RAM disk memory and *nn* Kbyte is for HP Instrument BASIC.
`DONE`	Terminates selecting memory partition and displays the following softkey labels.
`CHANGE YES`	Executes to change memory partition to one selected.
`NO`	Cancels to change memory partition and return to the previous softkey menu.

Caution When the memory partition is reconfigured, the analyzer goes to the initial settings. That is, the RAM disk memory is initialized and all the data saved in the RAM disk memory is destroyed, and the program on the BASIC editor is destroyed.

Display

DISPLAY ALLOCATION

Displays the following menu to allocate the BASIC screen area on the display.

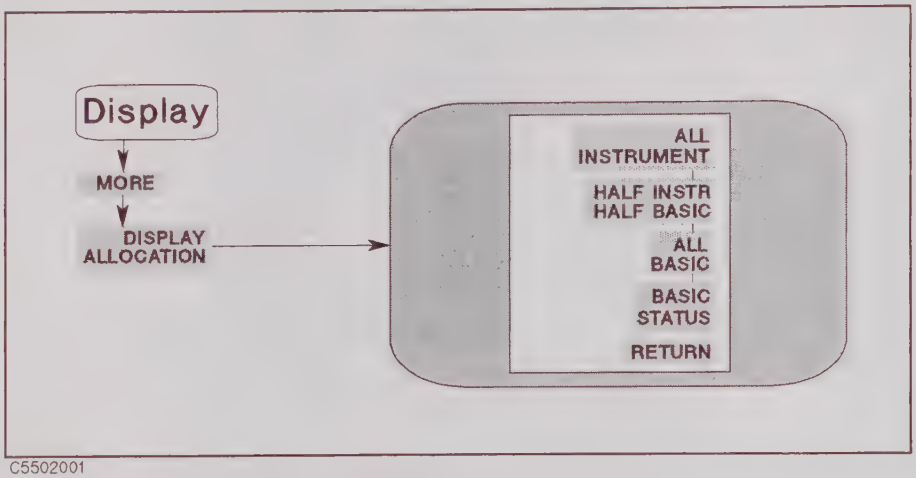


Figure D-3. Display Allocation Menu

ALL INSTRUMENT	Selects a full screen single screen or two half-screen graticules.
HALF INSTR HALF BASIC	Selects two half-screens, one graticule display above the HP Instrument BASIC display.
ALL BASIC	Selects a full screen single HP Instrument BASIC display.
BASIC STATUS	Selects a full screen graticule and three status lines for HP Instrument BASIC under the graticule.

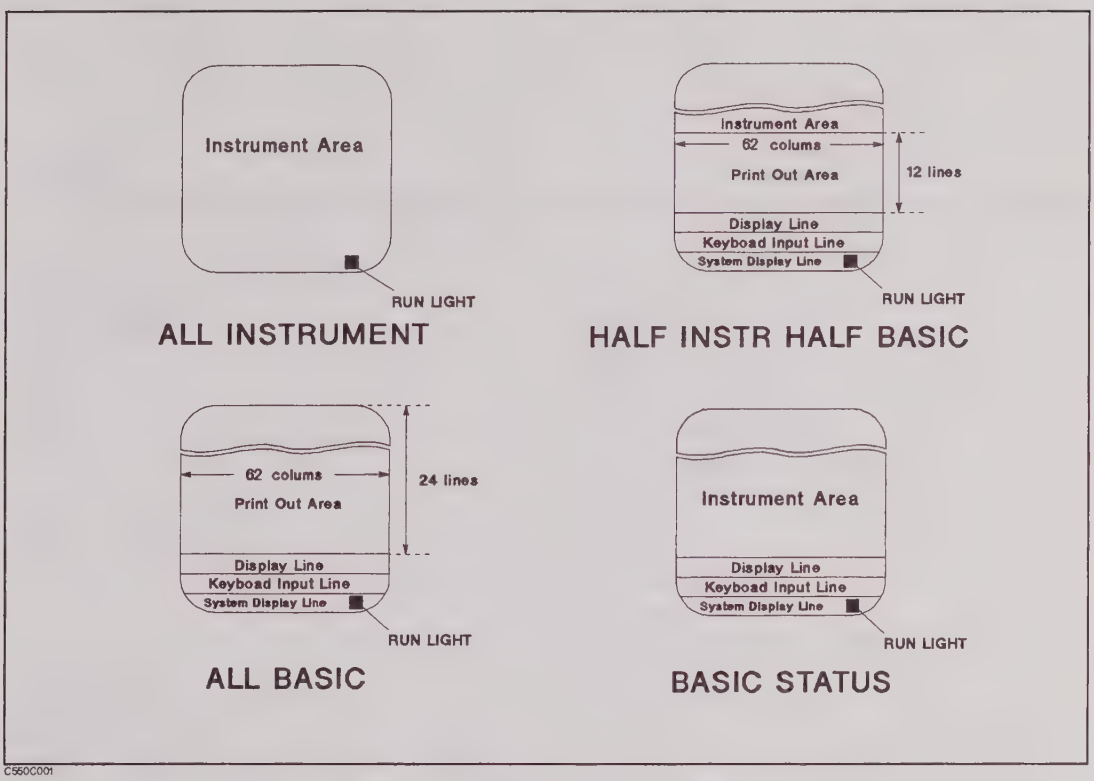


Figure D-4. Display Allocation

The following table lists the number of lines and columns in the BASIC print area for each display allocation. It also shows the keyboard input line status for each allocation. When the keyboard input line is available, you can execute BASIC commands from the keyboard.

Display Allocation	BASIC Print Area		Keyboard Input Line
	Columns	Lines	
All Instrument	0	0	not available
Half Instrument Half BASIC	62	12	available
ALL BASIC	62	24	available
BASIC Status	0	0	available

The analyzer can be connected to an external monitor. For information on the recommended monitor, see Chapter 9 of the *Function Reference*.

Run Light Indications

␣ (blank) Program stopped; can execute commands; CONTINUE not allowed.

\- Program paused; can execute commands; CONTINUE is allowed.

? BASIC program waiting for input from keyboard; cannot execute commands.

* This indication has two possible meanings:

- Program running; CANNOT execute commands. CONTINUE not allowed.
- System executing commanded entered from keyboard; CANNOT enter commands.

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